

## DOCTOR OF PHILOSOPHY

### Evaluating the extent of real exchange rate misalignment in China

Zhou, Dan

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# **Evaluating the Extent of Real Exchange Rate Misalignment in China.**

By  
**DAN DAN ZHOU**

**JANUARY 2009**

**A thesis submitted in partial fulfilment of the University's  
requirements for the Drgree of Doctor of philosophy.**



**The work contained within this document has been submitted  
by the student in partial fulfilment of the requirement of their course and award**

## **DEDICATION**

**To my great parents for their seemingly never-ending patience, tender loving care, support, encouragement and faith in me. I own them a debt of gratitude for being a constant source of motivation. I will always be grateful for their love and support.**

**To my beloved husband for his kindness, encouraging, and loving words that he always gave me when I was stressed out, and overwhelmed.**

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## Abbreviation

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criteria
BEER	Behavior Effective Exchange Rate
CFETS	China Foreign Exchange Trading System
CPI	Consumer Price Index
FDI	Foreign Direct Investment
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
IFS	International Financial Statistics
IMF	International Monetary Fund
ISR	Internal Settlement Rate
NEER	Nominal Effective Exchange Rate
OLS	Ordinary Least Squares
PPP	Purchasing power parity
PRC	The People Republic of China
QR	Quantitative Restriction
REER	Real Effective Exchange Rate
UK	United Kingdom
USA	United States of America
VAR	Vector Auto-regression
SVAR	Structural Vector Auto-regression
WB	World Bank
WTO	World Trade Organization

## Abstract

The dissertation investigates the issues pertaining to China's fixed exchange rate policy and attempts to appraise the case for greater exchange rate flexibility. The thesis addresses three objectives: First, a critical appraisal of China's exchange rate policy in the light of theoretical and empirical literature supporting greater flexibility in exchange rate; second, it builds a monetary dual exchange rate model and analyses in a dynamic theoretical framework the impact of nominal demand and price shocks due to over and undervalued currency. Third, using Chinese macroeconomic data it empirically examines the factors determining China's real exchange rate fluctuations.

After presenting a brief history of China's exchange rate policy in the post-war period, an assessment of China's fixed exchange rate policy is made, including the costs of maintaining its current peg. It is argued that the literature on China's exchange rate regime has not reached a consensus, and further theoretical arguments are appraised regarding the reluctance to move to a more flexible exchange rate regime. A theoretical dual exchange rate monetary model, in the spirit of Flood and Marion (1983), is then developed to analyse the dynamics in the responses to nominal and real shocks. This provides a theoretical basis for analysing the underlying working mechanism and policy implications under some degree of capital control, to resemble the Chinese exchange rate regime. In the light of the theoretical analysis, empirical research is conducted using a structural vector auto-regression (SVAR) model to examine the effects of real exchange rate fluctuations to nominal and real shocks (represented by inflation and real GDP), in order to determine the case for exchange rate flexibility. Both the theoretical and empirical analyses complement to inform the ongoing debate on whether the current exchange rate regime in China should be made more flexible, and whether a more flexible regime is appropriate in stabilising the effects of macroeconomic shocks.

The empirical findings reveal that the responses of the real exchange rate to nominal

demand and real supply shocks are consistent with a managed exchange rate system that currently operates in China. In particular, the results show that, as China has been under a fixed exchange rate arrangement for much of the estimation period, the real exchange rate appreciates immediately in response to a positive nominal shock. The use of quarterly Chinese data in this study, which no previous study on China has used, makes it possible to identify to a greater degree the initial appreciation impact of a positive nominal shock on the real exchange rate, although the results are generally consistent with the previous study by Wang (2004) using annual data. The study finds that supply shocks are dominant in the fluctuations of output growth, and while both nominal and real shocks are significant the nominal contributes more than real shocks in real exchange rate fluctuations. Overall, these findings are consistent with other studies for developing countries and support a case for greater exchange rate flexibility for China.

## **Chapter One Introduction**

### **1.1 Introduction**

Since 1979, China has gradually opened its market to the rest of world. During these last 30 years, China's economic transformation has been remarkable- from a poor planned economy with nearly one third of its population living below the poverty line to the world's fourth largest economy at present. China's economy has benefited its people by raising their living standard, and it has benefited the world by producing manufacturing goods at cheaper cost, which in turn can be seen as a contribution of low inflation to the world's economy. As a major player in world economy today, China's rapid economic growth is attracting politicians and economists' attention around the world. As of now, China's huge trade surpluses and fast accumulation of foreign reserves have raised tensions with its main trading partners, the US and EU. Main economic concerns have been the shrinking manufacturing base in industrialized countries and rising domestic protectionists against China's export growth. Lately, US authorities accuse China as "currency manipulator" and intensify pressure on Chinese authorities to revalue Chinese currency Renminbi (RMB) and change its US dollar pegged exchange rate regime to a more flexible one. For many emerging markets, especially export-led growth countries, fixed exchange rate arrangement is not a bad choice since it can stabilize the exchange rate volatility which is bad for exports. However, as the economic environment changes, such exchange rate regime may undergo real exchange rate misalignments. This will change the market expectations of the exchange rate

accordingly. Without any effective measures to put the volatile international capital flows under control, the perceived expectations will usually lead to rampant speculative activities that will in turn bring about massive pressure on the fixed exchange rate regime. In most cases, such speculations will ultimately lead to currency crises.

As an emerging market economy, China has maintained a fixed exchange rate regime in operation for decades. Coupled with strict administrative restrictions on capital flows, such an exchange arrangement has prevented China from the turmoil other SE economies experienced from the Asian financial crisis and provided favourable conditions for economic development. However, with the rapid growth of China's economy, the misalignment of the existing pegged exchange rate has become increasingly more apparent, potentially making Chinese economy vulnerable to a future crisis. Whether China should maintain the current pegged regime is now being hotly debated.

Since 2003, a considerable number of papers discussing the issue of RMB have appeared. Many academics and some institutions, like Barry Eichengreen (2003, 2004), Jeffrey Frankel (2004), Morris Goldstein (2004), Rumbaugh and Wang (2005), Roubini and Setser (2005), Goldstein and Lardy (2007), World Bank, and International Monetary Fund, have stated their viewpoints on this issue respectively. These writers have tried to employ different approaches and models to fathom the costs and benefits of the current peg of RMB's exchange rate. Although most of them agree that the fixed exchange rate regime is gradually falling out of time due to the

already changed economic situations in China, they cannot reach a consensus on the steps and timing of adjusting the exchange arrangement.

## 1.2 Relationship and Motivation of the study

During much of the 1980s, China had a fixed exchange rate system although the *renminbi* (RMB) was devalued frequently, reflecting economic developments and waves of opening up the economy. Between 1988 and 1993, China had a dual exchange rate system in which the official fixed rate coexisted with the market-determined rate in the swap centres. Since 1994, following steady depreciation of the swap market rate, the official rate was devalued and unified with the swap rate. Since 1995, China's exchange rate regime has officially operated as a managed float system with the RMB pegged at around ¥8.3 to the US dollar.

Since the Asian and Latin American crises, however, China's exchange rate policy and the merit of the RMB's *de facto* peg has been the subject of growing debate (Xu, 2000; Roberts and Tyers, 2003). On the one hand, following China's WTO accession, an influx of foreign direct investment and portfolio capital is expected to contribute to RMB appreciation. On the other, the relaxation of capital controls will encourage foreign spending by Chinese residents and allow a possible current account deficit fuelled further by booming domestic investment. To maintain external balance, it is clear that China's exchange rate is likely to require further realignments. However, views differ as to whether China's should adopt a more flexible exchange rate as it pursues a policy of trade and capital account liberalisation. Xu (2000) argues



that exchange rate stability has served as an effective anchor for price stability and suggests a gradual approach towards capital account liberalisation. Roberts and Tyers (2003) argue that liberalisation will increase the likelihood of external shocks and therefore China will benefit more with exchange rate flexibility. Shen (2002) suggests domestic and financial sector reforms will be reinforced by the managed float that is likely to result from WTO accession. All these studies present their case from a macroeconomic perspective and accept the view that more flexibility will be inevitable with capital market reforms, but differ in how this could proceed.

China's recent rapid export growth and accumulation of international reserves have generated considerable interest in modelling the determinants of the RMB exchange rate. Much of the existing literature has focussed on the valuation of the exchange rate relative to its equilibrium. Chou and Shih (1998) estimate the equilibrium exchange rate of the RMB between 1978 and 1994 using both the purchasing power parity (PPP) and the shadow price of foreign exchange (SPFE) approaches, and find that the RMB was overvalued for much of this period, but came close to equilibrium between 1990 and 1994. Zhang (2001) estimates a behavioural equilibrium exchange rate over the period 1952-1997 using a set of fundamental determinants of the actual real exchange rate for China, and finds that the RMB was overvalued for most of the estimation period, but came close to equilibrium in 1997. More recently, Anderson (2003) has estimated a partial equilibrium model centred on trade equations for China and finds that the RMB real exchange rate is, at present, undervalued.

With the liberalisation of trade and investment in coming years, China will most likely face an increase in nominal and structural shocks, which may cause significant variation in its real exchange rate even though the nominal exchange rate is pegged. Instead of estimating the equilibrium real exchange rate, the empirical methodology will attempt to gain insight into the underlying forces driving the actual real exchange rate for China. Following the pioneering study of Blanchard and Quah (1989), there has been a growing body of literature in which the long-run relationships from theory are used to identify structural shocks in an open economy setting. There is some empirical literature on the conventional approach of modelling and estimating the real equilibrium RMB exchange rate to determine whether China's high export competitiveness is the result of its nominal peg. Chou and Shih (1998) and Zhang (2001) follow this approach and conclude that the RMB was overvalued in the 1980s but subsequently came close to equilibrium in the late 1990s. More recently, researchers have used a structural Vector Auto-regression (SVAR) approach to study the evolution of the real effective rate and identify the sources of its variability. Wang (2004), pursuing this approach, finds that supply shocks are as important as nominal demand shocks in accounting for real exchange rate movements in China, in contrast with other studies that show that, in industrial countries, nominal shocks are more important. A useful extension of this analysis is to examine the implications for the choice of the appropriate exchange rate regime for China, similar to that undertaken by Ahmed (2003) who concludes that exchange rate rigidity in Latin American countries may not be as costly as conventional economic theory predicts.

A key issue in the SVAR approach is to decompose real exchange rate movements and gauge the relative importance of monetary and exchange rate policies. Underlying this approach is the selection of appropriate variables that constitutes the VAR, and the structural approach imposes long-run restrictions from theory and allows identification of short-run influences. Such an analysis is a useful supplement to the VAR approach of Fackler and Rogers (1995), Reinhart (1995), Edwards and Vegh (1997), and Montiel (1997). This line of enquiry follows Ahmed (2003) who studies the sources of economic fluctuations in key Latin American countries and concludes that exchange rate rigidity may not be as costly for these economies as conventional economic theory predicts.

Therefore, this study seeks to emphasise whether through a review the literature surrounding the debate on China's exchange rate policy there is a case for greater exchange rate flexibility and critically assesses arguments for and against greater exchange rate flexibility.

In addition, emphasis will also be placed on whether the current exchange rate regime in China should be made more flexible, and the property of such more flexible regime in stabilising external shocks. To cater for the specific situations in China, a dual exchange rate model, in the spirit of Flood and Marion (1983), is used. Such a model can also be used as a framework to organise conflicting views regarding how exchange regime in China should be reformed.

Finally, the empirical methodology, following Ahmed (2003) and Wang (2004), will be to estimate a structural Vector Auto-regression (SVAR) model using quarterly

data for China over the past ten years, thus covering recent episodes of exchange rate crises and financial liberalisation. The primary goal here will be to examine the implications of the results for the choice of the appropriate exchange rate regime for China.

### 1.3 Research Objectives

China's rapid economic growth and accumulation of foreign exchange reserves has sparked tensions with the US about its ongoing policy of exchange rate stabilization, keeping the Renminbi (RMB) pegged at around ¥8.3/US\$. This research aims to investigate the issues surrounding China's exchange rate policy and evaluate the case for greater exchange rate flexibility.

Specific objectives are:

- (i) To critically analyse the debate on China's exchange rate policy in the light of the theoretical literature on the arguments for and against greater exchange rate flexibility.
- (ii) To build a theoretical monetary dual exchange rate model which can allow for measuring the extent of currency over (under) valuation, after having controlled for the intervention effect of nominal and real variables on financial exchange rate. This model manifests flexibility by allowing us to examine the effects of any combinations of the accommodated variables. It also provides a framework to investigate the underlying working mechanism and the policy implication, particularly for those regimes with some degree of capital control.

- (iii) To identifying the variables that can explain changes in the real exchange rate in china. And to empirically examine the factors determining China's real exchange rate and conduct empirical research through the structural Vector Auto-regression (SVAR) model to study the relative importance of different types of macroeconomic shocks for fluctuations in the real exchange rate. Hence, to determine whether and how in the light of the empirical results China's exchange rate is overvalued or undervalued.

## 1.4 Research Methodology

To accomplish the above objectives, this study utilises both qualitative and quantitative analysis. First the study focuses on surrounding the debate on whether the current exchange rate regime in China should be made more flexible, and identifying the theoretical case for a more flexible regime in stabilising external shocks. To cater for the specific situations in China, a dual exchange rate model, in the spirit of Flood and Marion (1983), is used. Such a model can also be used as a framework to organise conflicting views regarding how exchange regime in China should be reformed.

In addition, this study also takes the Quantitative approach. The quantitative approach is represented here by the econometric analysis (Time Series Analysis) of documentary secondary data. The data in the research is gathered from quarterly from International Financial Statistics (IFS) June 2005 edition, China Statistical Yearbook 2004, and China Statistical Bureau. The data covers the period (1994:1 –2005:4). We take the two countries- the U.S. and China.

In the second stage after gathering the data, a structural Vector Auto-regression (SVAR) model will be utilized in the research by using the variables: the real exchange rate, domestic and foreign inflation rates, and real GDP and trade-openness. Instead of using nominal values, we consider the log of the domestic and foreign (US) price levels measured by the Consumer Price indices (CPIc and CPIa), the log of real exchange rate REER, the log of real GDP and log of trade-openness TRADE. The structural VAR model is used because this research approach identifies the dynamic effect of interdependent of one variable on another. In the structural econometric approach, it is not possible estimate and interprets each coefficient, especially if signs of the coefficients alternate. Furthermore, data and time constraints limited the empirical analysis to the more simplified structural VAR approach.

The tests that will be used in this research in structural VAR model will include: Selection of the lag length, Unit root test, Johansen Cointegration test, Impulse response function and Variance decomposition. These tests will be examined by using Eviews (release 6.0) package.

## 1.5 The Research Structure

This study looks at firstly whether the current exchange rate regime in China should be made more flexible, and examines the response of the real exchange rate in stabilising the effect of external shocks. To cater for the specific situations in China, a dual exchange rate model, in the spirit of Flood and Marion (1983), is used. Secondly, the empirical analysis evaluates the extent of misalignment of the Chinese exchange

rate and determines whether the level of exchange rate China should be more flexible than the current situation. To accomplish these two targets, the research is organised as follows.

In Chapter 2, we have an overview on the evolution of the exchange rate regimes, and the history of China's exchange rate arrangements. This chapter consists of several parts; it starts from China's pre-reform period 1949, the first round reform in 1978 and the Internal Settlement Rate adoption, the foreign exchange swap market development, Exchange policy before, during and after Asian Financial Crisis.

Chapter 3 reviews the literature on the reason of adopting fixed exchange rate regime and how China's exchange rate regime could evolve and contribute through greater flexibility. The main thrust of this survey is to analyse from the literature whether China should move towards a more flexible exchange rate regime. However the aim is not to predict when true exchange rate flexibility is most likely to occur.

Chapter 4 presents the dynamic model of the dual exchange rate, appropriate for the theoretical analysis. The dual exchange rate regime works as fixed exchange rate with capital controls as we will see later. The chapter then describes the model and analyses the dynamics and its stationary equilibrium. Two cases will be considered: one analyzes the effects of a permanent domestic credit expansion on the economy; the other analyzes the effects of domestic output movements.

Chapter 5 is the empirical analysis of RMB revaluation. The research methodology, data collection, the model and variables and the hypotheses are discussed. Preliminary data analysis and final estimation results are presented and discussed in this chapter as

well. The structural VAR decomposition shows that different relative shocks account for different level of the variations in real exchange rate changes during the estimation period.

Chapter 6 summarises the main findings from the evolution of China's exchange rate regime, and evaluates the case for greater exchange rate flexibility.



## **Chapter 2      A Historical Evaluation of RMB Exchange Rate**

### **2.1 Introduction**

China finally unveiled its economy to the world in 1979. Since then its foreign exchange policy has never stopped reforming in order to be consistent with its economic reform. China's foreign exchange reform has been a namely gradual transformation of its exchange allocation mechanism (Mehran, Quinton and Laurens, 1996; Lin 2003) from one that was completely controlled by central planner to the one where market determination has become important. The reform process took the first step by liberalizing trade, then developing an exchange market and finally easing restrictions for current account and the establishment of a capital account control structure. After nearly thirty years of effort, China is now facing the last formidable task of its exchange reform- capital account liberalization. This task would have been done before 1997, but the Asian financial crisis reminded policy makers of the high risk of opening up the capital account without a sound financial system. In 2001 China was eventually accepted by WTO, and as a result, as promised, China has had to open domestic financial markets gradually and substantially to foreign investors. Previous reforms can be seen as China is attempted to focus on the liberalization of the current account and attract inward foreign direct investment, aimed at pushing up the export of the economy. The next phase of reform is mainly to shape the financial sector in a way that can sustain capital account liberalization.

The process of China's foreign exchange policy reform began with introducing a system in which exporters would keep a portion of their foreign earnings in 1979.

Later on the government introduced the Internal Settlement Rate for trade transaction aimed to regulate import and export activities through manipulating an administratively determined exchange rate. After the mid 1980's, market determined exchange rate developed rapidly- the first foreign exchange swap centre was established; also the authorities allowed trading of foreign exchange to encourage inflows of foreign direct investment. At the beginning of 1990's the swap market played a significant role in foreign exchange transaction. Later on further exchange rate reform was done by unifying the official and swap market rate. In 1996 China liberalized its current account. Since then the Asian Financial Crisis influenced China's decision to delay capital account liberalization, thus the authorities have mainly focused on consolidating current account convertibility while the pace of capital account liberalization remained slow.

Figure 2.1 Dynamics of Exchange Rate of RMB against US Dollar since 1949.

Source of data: Ministry of Commerce of the People Republic of China.  
Official Website: [www.mofcom.gov.cn](http://www.mofcom.gov.cn)

Figure 2.1 shows the dynamics of dollar's RMB rates from 1949 to August of 2005.

From this graph, we can see several inflexion points or discontinuities in the RMB exchange rate. These turning points can be connected back to a few crucially influential events associated to the change of either international monetary system or domestic economic policy. Generally speaking, three periods can be distinguished chronologically from 1949 to 2005.

Period one, briefly states the foreign trade and exchange regimes from 1949 up to 1979. The second period describes the 1979 reform and 1980's adoption of Internal Settlement Rate (ISR). The third period focuses on the development of foreign exchange swap market from later 1980s to 1990s. While the last section concentrates on the exchange policy change before and after the Asian Financial Crisis. Part five concludes. The rest of this chapter follows this timeline to describe the history of China's foreign exchange rate policy and the process of the foreign exchange rate reform.

## 2.2 1949 -1978: The Period of Planned Economy

This time span can be again minced into three shorter periods: 1949 to 1952, 1953 to 1972 and 1973 to 1978. In the first three years or so, the exchange arrangement adopted by the central government can be regarded as an exchange rate regime with higher flexibility because the RMB rate against US dollar was adjusted with the terms of trade from time to time. But the magnitude of fluctuation in RMB exchange rate was rather small. Since 1953, the external value of RMB was fixed by the authorities at a level of 2.617 Yuan per dollar. Thereafter, RMB underwent a minor devaluation

and was finally maintained around 2.46 RMB per US dollar. This exchange rate lasted until 1970. Before 1973, the year when intermittent dollar crises ultimately caused the Bretton Woods currency system to break down, the RMB exchange rate appreciated slightly, from 2.4618 to 2.2401 Yuan per Dollar. From 1973 to 1978, the RMB exchange rate was more volatile and seemed to be seeking an equilibrium value. Before the early 1970s, the exchange rate of RMB was officially set and was under the direct control of the government. The relatively small amount of foreign trade meant the exchange rate of RMB has an insignificant effect on the planned economy. Although the exchange rate did adjust over time with domestic and international economic political situation, it should not be thought of as a real reflection of the trade flows of goods, service and capital between China and the rest of the world.

China pre-reform foreign exchange system was built on its central planned economy and can be seen as being inefficient. China's foreign trade was mainly controlled by a few government owned foreign trade corporations. Before the 1979 reform there were only ten foreign trade corporations that possessed most of China's foreign trade share. The intention of this monopolistic structure was to help insulate the economy against foreign shocks. The authorities could manipulate foreign trade plans in accordance with the target of central planned economy in which exports generate enough foreign exchange to support imports, while imports were expected to fill the gaps of the domestic demand and supply.

Under the pre-reform foreign trade system all the foreign earnings were surrendered to the state and the requirement of foreign exchange was also allocated by

government. The power to control foreign exchange was shared by several ministries such as the ministry of foreign trade, the ministry of finance and the central bank. These authorities would compensate the loss if the foreign trade corporations suffered a home currency loss in the transactions through central budget. Thus all the domestic importers and exporters had to hand in the profit to the state. This system can be seen as a mechanism of auto tax-subsidy in which exchange rate can ignore the change of price level and other macroeconomic variables.

However this central planned economy was inefficient in respect to foreign trade, as this monopolistic system constrained competition among domestic trading firms whilst the central planning deprived firms' autonomy; also there was little low incentive for efficiency for these foreign trade firms as the moral hazard can be caused by the central budget.

As we can see, before the reform exchange rate was not a functional tool for the foreign trade to regulate the market demand and supply. Since the exports were relatively small the impact of overvalued or undervalued exchange rate did not influence the domestic economy very much. The major role played by the exchange rate in the central planned economy was that of the "passive accounting role" (Van Brabant 1985).

### 2.3 1979 reform and the Internal Settlement Rate adoption

The first reform of exchange rate policy was carried out on August 1979. With respect to the inefficiency of central planned economy the reform focused on breaking up the monopolistic system and the centrally planned economy. Fundamentally the

aim of this initial reform was to transform the foreign exchange allocation mechanism from one controlled by government to the one more or less determined by the market. Some of the foreign trade management power was decentralized, and more foreign trade firms were established, in particular central government allowed some major cities to set up their own foreign trade corporations. At the beginning of 1980s there were estimated four hundred new foreign trade firms established. In mid 1990s the number increased to ten thousand. The notable figure during this period is the traditional trade firms before 1979 accounted for more than two third of foreign trade in early 1980s. In 1992 the shares declined to less than one fifth (see Table 2.1).

Table 2.1 China's 10 Foreign Trade Corporations' Share of Annual Imports and Exports 1981-1992 (%)

Note: The 10 foreign trade corporations that controlled most of China's foreign trade in 1978 are: China Machinery Import and Export Corp., China Minerals and Metals Import and Export Corp., China Chemical Import and Export Corp., China Technical Import and Export Corp., China Cereals and Edible Oils Import and Export Corp., China Textiles Import and Export Corp., China Native Produce and Animal By -Products Import and Export Corp., China Light Industrial Products Import and Export Corp., China Arts and Handcrafts Import and Export Corp. and China Instruments Import and Export Corp.

**Source:** Ministry of Foreign Trade and Economic Cooperation.

The above reform was accompanied by further reform of the exchange rate policy.

Authorities set up foreign currency control department i.e. the State Administration of Foreign Exchange, and in the same year (1979) government also allowed export sector to retain a fraction of foreign earning aiming to introduce incentives among exporter, even though it appeared that the export sector was not profitable. The reason was due to: firstly, the distortion of the exchange rate before 1979 which caused the overvalued domestic currency<sup>1</sup>, and secondly the abolishment of central budget, which led to no central planned allocation. With respect to the unprofitable export authorities the introduced RMB Internal Settlement Rate in 1981 was fixed at 2.8 Yuan. The ISR only covered trade related exchange transaction, as for non-trade transaction the authorities still retained the overvalued exchange rate. This dual exchange rate system was caused by a debate over the appropriate level of RMB exchange rate among economists and politics in 1979. Two conflicting views prevailed about whether the RMB was overvalued or undervalued. One group suggested that the official exchange rate had underestimated the value of RMB by contrasting the price level of other developed countries<sup>2</sup>. According to the purchasing power parity a basket of goods and services mostly favoured foreign tourists. On the other hand, the other group believed that official exchange rate was overvalued. This view concerned the export sector and growing export subsidies suggesting exporters were not able to cover their export costs. Wu and Chen (1989) pointed out that unprofitable exports accounted for 66 percent of China's total exports. Between these

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<sup>1</sup> In 1979 the national average cost of earning one unit of foreign exchange was 2.4 Yuan per dollar while the official exchange rate was at 1.5 Yuan. The cost of many exportable goods could not be covered at the official exchange rate.

<sup>2</sup> The foreign exchange authorities compared the relative prices of basic consumer goods and services of Beijing with New York, London, Tokyo and Hong Kong. The result showed that the RMB should appreciate to around 0.54 Yuan per dollar.

views authorities eventually choose to adopt dual exchange rate system in which official exchange rate was in charge of non-trade foreign exchange transactions and the depreciated ISR took care of trade related foreign exchange transactions. It is noted that the official exchange rate did not follow the appreciation view since the authorities believe the economic reform could bring the price level up (Wu and Chen 1989).

The introduction of ISR was the first attempt for authorities to adjust the RMB exchange rate according to the structure of domestic prices since the new regime took charge. It can be seen as one of important events in the development of China's exchange rate policies (Lin 2003). However in about thirty years (1949-1979) of central planning and control the price distortion was serious, thus it could not expect that the ISR would be at equilibrium level. Even though, the ISR adoption more or less alleviated the extent of the RMB overvaluation and to the appreciated official exchange rate. However the ISR only played a very limited role in regulating the export and import market (Lin 1997). The reason is that although the reform was intended to increase the number of foreign trade firms, yet the reform was not thorough, and the state still had the power over decision making and finance. The ISR hence could not be adjusted by following market supply and demand force. The major disadvantage of ISR is that there exists arbitrage opportunities. Foreign trade firms could sell foreign exchange to the bank but use the official rate when they bought foreign exchange from the bank. For the period when the ISR was in use the overseas Chinese remittances through official channels dropped drastically from around \$650



million annually in the late 1970's to \$171 million in 1985 (Lardy 1992). The ISR was in use from 1981 to 1984. During this period domestic prices had increased steadily. There was a pressure for the devaluation of the official exchange rate close to ISR. The pressure from other countries mounted, such as USA accused China used ISR to subsidize export sector. In late 1984 China finally abolished the ISR and official exchange rate was devalued to 2.8 Yuan per US dollar.

## 2.4 The foreign exchange swap market development

The aim of 1979 reform was to establish more foreign trade firms at local governments level and thus to decentralize foreign trade management. After the abolishment of ISR, State Council decided to introduce second round of reform in 1984. To encourage inflows of foreign investment the government decided to further open up the market. Unlike the 1979 reform, the 1984 reform focused on making foreign trade firms independent of government controls. Authorities intended to separate government control from enterprise management and from financial control. Sung (1994) states that the full implementation of this proposal could fundamentally change China's foreign trade sector.

However, this proposed reform package was not fully delivered, because of the Chinese economic shock in late 1984. From the end of year 1984 to 1985, China's trade balance increased from \$1.3 billion to \$2.6 billion. At the same time the overheated economy caused rapid domestic inflation. These two factors together lead to the authorities' decision of centralization again. Lardy (1992) pointed out that with

authorities' adoption of few administrative measures to control the domestic demand and imports, a lot of delegated powers were handed in from local government level. Also because of the high trade deficit (low foreign reserve) and domestic inflation, in late 1985 the official rate of RMB was subject to devaluation- a series of from initial 2.8 Yuan per dollar to 3.71 Yuan per dollar.

The serial of devaluation of RMB, however, did not solve the problem of the overvalued official exchange rate. In order to offset the adverse effect of overvalued exchange rate the government had to introduce several distorted policies. The idea is that once a distortion is introduced into the economy, according to the theory of second best few more distortion policies are worth introducing to offset the adverse effect of the first one. During the period from 80s to early 90s the government implemented direct and indirect measures, such as direct export subsidies, foreign exchange retention system, export tax rebates and swap markets, to offset the overvalued RMB. However, these compensating policies motivated the exports and increased the exports volume, eventually the growing subsidies turned to a heavy burden for government. To offset the adverse effect of export subsidies, from the mid 80s to early 90s the foreign exchange swap market played a significant role in China's foreign exchange system.

The foreign exchange swap market development did not follow the step of the foreign exchange retention reform (Lin 2003). In the first round reform, government allowed Chinese foreign trade firms to retain a partial of foreign exchange earnings which were in the form of quotas. In 1980, government introduced a quota trading

system in some major cities. Holders of retention quotas were permitted to transfer their quotas to other domestic firms. In later 80s the foreign exchange retention system further opened up from 15 percent for the general commodities to 25 percent. The overheated economic activity in late 1980s, caused black market rate lower than the swap rate. As a result a new foreign exchange swap market was set up in special economic zones. The liberalization of FDI also enforced the exchange reform in late 1980s. To motivate the capital inflows, the government allowed the foreign firms to swap foreign exchange among which the buyers and sellers negotiate the swap price. Thus a dual foreign exchange rate appeared in China again. Unlike the former one, the swap rate was an important tool to offset the distortion effects of the overvalued official exchange rate (Lin 2003). In this dual exchange rate system the official market relied on the amount of foreign exchange surrendered by domestic exporters whereas the activities of swap market depended on the exporters' foreign exchange retention and foreign firms. In this system the importers were the net winner since government allocated the surrendered foreign exchange to them at the official exchange rate. The exporters also could have some gain generated by the system as they can trade their foreign exchange retention with at depreciated exchange rate in the swap market.

The swap market experienced further developments in 1988 as the government allowed the increase of foreign exchange retention ratios and more swap market centre. A 70 percent retention ratio was applied in the light industrial products sector and the exports of electronic and machinery products could have 80 percent of

retention ratio (Lin 2003). All provinces established the swap centres and a central swap market was established in Beijing. Thanks to these series of foreign trade reform the volume of transactions in swap market increased from \$ 1 billion in 1984 to \$86 billion in 1989.

However, the swap market did not develop smoothly. As Chinese reformers persisted in the efforts at price liberalization, the inflation expectation led to serious domestic inflation in 1988- the rate of inflation rose to 27 percent. At the same time the trade balance deteriorated, the trade deficit reached \$7.8 billion. While the official exchange rate remained at 3.7 Yuan per dollar, the swap rate fluctuated drastically. In the early 1988 the exchange rate was 5.7 Yuan per dollar, in the mid of 1988 the exchange rate depreciated to 6.8 Yuan per dollar. The situation worsened in the mid 1989, the Tiananmen Square “June 4<sup>th</sup>” students’ demonstration led to low confidence of China’s economy. After this incident the authorities tightened the control of the economy. The economic situation got better. The trade deficit decreased to \$6.6 billion in late 1989. And in 1990 the trade balance turned to surplus. During this period authorities also implemented two rounds of official exchange rate devaluation. The first round was on December 1989 the RMB decreased by 21 percent to 4.7 Yuan per dollar. The second devaluation was adopted in late 1990 to bring the official rate down to 5.22 Yuan per dollar. As for swap market, the exchange rate dropped down to 5.4 in 1990 (Lardy 1992). During this period the swap market exchange rate really play a profound role in the foreign exchange market. The swap market led to the realization of the link between the change of money supply and the change of

exchange rate in China since the 1979 reform. Since the authorities tightened the domestic credit an excess demand for money appeared, and eventually it brought the appreciation of RMB in the swap market.

The third round of reform took place in 1991. This time the authorities aimed to firstly remove the export subsidies, secondly increase the foreign exchange retention ratio, and finally abolish the quota system. In order to relieve the burden of the central government the export subsidies had faded away through a gradual process, when the foreign trade contract responsibility was adopted in 1988 reform. The authorities initially did the reform experiments on the foreign trade sectors of light industrial products and garments, and the result showed that these foreign trade enterprises could survive without export subsidies. Later on government removed the export subsidies in all foreign trade sectors. A unified retention scheme was adopted in the early 1991. Exports using imported inputs could retain as much as 90 percent of foreign exchange earnings. Some special exports such as military product and special regions could get 100 percent retention. In the sectors of general commodities, the exporters could have the retention ratio of 40 percent, while the rest would be surrendered by central and local government. For the export of machinery, electronic products, a ratio of 65 percent was applied to foreign trade firms, while the central government would receive the other 30 percent at the swap market rate. The abolishment of quotas was in action in late 1991. The quota system was a controversial issue (Lin 2003). The retained foreign exchange was kept by central government and Bank of China. They usually took the foreign exchange in another

use. Thus when foreign trade enterprises or local governments intended to exchange the quotas into foreign currency it often appeared to experience delay and shortage. To resolve this incredible quota system, the authorities experiment a new system in which the foreign trade enterprises and local government could retain cash instead of quotas in some special economic zones. Eventually, the new system spread out in China. By 1993 there were 108 foreign exchange swap market across the country, and the volume of transactions is above \$20 billion every year since 1991. Before 1991, the foreign swap market took 50 percent share of China's foreign exchange transactions, whereas after 1991 it increased to 80 percent (Lardy 1992). The increased role of the swap market in settling foreign exchange transactions was mainly due to the continuous increase of the retention ratio.

In 1992 "the third generation leadership" was formed; the new authorities continued to open up the market aiming to establish a socialist market economy. Until the mid of 1992, it authorised 24 inland and 14 border cities to foreign investment. Also in order to become a member of GATT, China introduced a tariff reduction on 225 items to liberalize its import policy. In the mid of 1992 China abolished the import surcharge that was imposed to control the trade deficit. Furthermore In late 1992 it announced a second tariff reduction on 3,371 items.

Because of the trade liberalization and the rapid economic growth, the demand for foreign exchange increased between 1992 and 1993 (Khor, 1993). Thus the swap exchange rate reached 6.05 Yuan per dollar in April 1992. In 1993 as China's economy got worse, the exchange rate depreciation worsened. The swap market rate

climbed to 8.34 Yuan per dollar. To counter this rapid depreciation, authorities imposed a limit on the swap rate at 8.2 Yuan per dollar. However, this policy contracted the volume of transactions in swap market and most deals were done in black market. Eventually the authorities had to remove the limit and the swap rate reached 11 Yuan per dollar in the mid of 1993 while the official rate was still at 5.7 Yuan per dollar. Aiming to cool down the economy the authorities took drastic anti-inflationary measures; also the government took the campaign on cracking down the black market. As a result, the swap rate fell back at 8.8 Yuan per dollar in July.

## 2.5 Exchange policy before Asian Financial Crisis

Aiming to get the accession to the WTO, in 1994 China deepened the economic reform on foreign exchange, foreign trade and investment. As for foreign exchange reform, the RMB official and swap rates were unified at the rate of 8.7 Yuan per dollar at the end of 1993. Accordingly the swap market was abolished and the foreign exchange retention system was terminated as well. The foreign exchange control on imports was also abolished. Importers could purchase foreign exchange needed for import activities by showing the authorities import contracts or valid documents (Tseng 1994). At the time the exchange regime was named as managed floating rate, which allowed the exchange rate for US dollar to fluctuate in the range of 0.15 percent.

On 4<sup>th</sup> of April 1994, the China Foreign Exchange Trading System (CFETS) was established instead of swap market. The previous foreign exchange swap centres were

transformed in the local branches of the CFETS and were linked to the centre in Shanghai. Unlike swap market, the new system was formed by domestic financial institutions, and foreign banks. In addition, the central bank also became a participant in interbank trading. The CFETS is authorized to approve membership system based applications.

After the exchange rate unification, the trade balance had changed dramatically. It turned from deficit in 1993 into a surplus of \$5.4 billion in 1994. At the same time the inflow of foreign capital reached \$32.6 billion given the overall balance of payments surplus of \$30.5 billion. Eventually the foreign exchange market faced the excess demand of domestic currency pushing the appreciation of RMB in the mid of 1994. The exchange rate was up from 8.7 Yuan per dollar to 8.4 Yuan per dollar. To tackle this appreciation, the authorities intervened the market by accumulating the foreign reserves. Consequently the foreign reserve almost tripled from \$26.4 billion to \$77.9 billion. By doing so the RMB exchange rate tended to stable around 8.3 Yuan per dollar and closed to 8.28 Yuan per dollar in the end of 1996.

At the beginning of 1996 the government announced regulations for foreign exchange administration. The regulations were generally aiming to tighten the control on capital account, meanwhile to pursue the current account convertibility. In order to pave the way to the full current account liberalization, the government relaxed the control on private foreign exchange transactions such as allowing traveller exchange \$500 to \$1000 if they go abroad, and allowing domestic and foreign residents to carry up to 6000 Yuan out of the country (Shang 2000). In addition, the trade barriers were



also lowered to some extent. China's average tariff level was brought down from 35.9 percent to 23 percent. Three years ahead of the official timetable, in the later 1996 China finally attained the current account convertibility by accepting the obligations under Article Eight of the IMF's Articles of Agreement<sup>3</sup>.

The capital account control however was still tight. This led to large volume of illegal capital flight. Gunter (1996) pointed out that between 1984 and 1994 the amount of capital flight could reach \$75 billion. Song (1999) disagree this figure and suggested that the figure exceeded \$20 billion each year after 1993, and in 1997 it was over \$40 billion. To tackle the illegal capital flight the authorities have enacted various measures to control capital outflows, such as adopting a system for verification of export receipts and a system for verification of import payments. The government also implemented the compulsory surrender system in which domestic firms has to hand in their part of the foreign exchange income.

## 2.6 Exchange rate policy during Asian Crisis

With the advent of the 1997-1998 Asian Crisis, the well known "Asian miracle" became "Asian Miserable". The speculative attack on Thai Baht triggered wild range of currency devaluation in other countries such as Korea, Indonesia, Philippines, Thailand, Taiwan, and Singapore. Unlike usual currency crisis in Latin American countries where currencies were attacked because of bad fiscal policy and currency overvaluation in the sense of purchasing power parity, the currency attacks were

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<sup>3</sup> For details see IMF [www.imf.org](http://www.imf.org).

provoked by an undue build up of short-term dollar indebtedness over 1994-1996 (Mckinnon 2002). Eventually the debtor countries Korea, Indonesia, Philippines, and Thailand were forced to devalue and adopt floating exchange rates<sup>4</sup>. Whereas China and Hong Kong retained their dollar pegs. IMF attributes the cause of this crisis to the before 1997 system of fixed exchange rate policy in Asian countries. It is because in East Asian debtor economies the interest rates were much higher than on dollar assets. Thus, in order to make loans in say, RMB, Chinese banks were tempted to accept low interest rate dollar deposits instead of high interest RMB deposits. This temptation was great since the Yuan/dollar exchange rate was fixed, which causes the moral hazard for banks. IMF thus suggested that if the exchange rates of the debtor countries have been more flexible, the banks would be less tempted to over borrow in foreign exchange ex ante, and there would be no large depreciation ex post (Mussa et al, 2000)

Beginning with Thailand in June 1997, to Korea in December 1997 and Japan in early 1998, the Asian Financial Crisis began to substantially affect the Chinese economy in 1998. To boost their credibility, China's authorities announced a stability of RMB exchange rate. In the period of Asian Financial Crisis, the RMB exchange rate fluctuated in the range of 0.1 percent. Hence the export growth rate was only 0.6 percent in that year. In addition, depreciations in its neighbour countries imposed strong deflationary pressure on China, the consumer prices grew at a negative rate in early 1998. Thus, in March 1998 the authorities enacted a series of fiscal expansion

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<sup>4</sup> Whether these countries really adopt floating rate is debatable as Mckinnon (2002, 2004) argues that the fluctuation of their exchange rates is really the phenomenon of exchange rate overshooting during the Asian Crisis. We will see more in detail in the next chapter.

aimed at getting the economy out of the likely recession. Since 1998 public works have increased by 20 percent per year. The announced stimulating pack amounted to 150 billion RMB, financed by the sale of public bonds and by borrowing from the state-owned banking system. In 2002 the official yearly budget deficits rose from 0.7 percent of GDP in 1997 to 2.8 percent of GDP.

The foreign reserves hardly increased in 1998. The authorities thus tightened the control of the capital flight. It implemented high standard of requirement on foreign exchange transaction and conversion and remittances of foreign exchange. Numbers of notices and regulations on foreign exchange supervision were issued and a nationwide campaign on cracking down the illegal foreign exchange activities was enacted.

China's decision of not devaluating RMB has been well recognized by their neighbours during Asian Crisis (Fernald and Babson, 2000, Song, 1998, Tyers and Yang, 2000). Frankel (2002), and McKinnon and Shnabl (2003) argue that China played an important stabilizing role during the turmoil. First comparing with other East Asian countries, such as Indonesia and Thailand whose GDP heavily depended on export; China's trade was only around one third of its GDP. Due to the relatively large proportion of domestic sector, exchange rate plays a less important role in China; in turn it is less sensitive to shocks from abroad. Thus with growth mainly contributed by domestic factors, China was able to immune itself from most of its Asian Crisis. Second, China's resistance of RMB devaluation dampened the domino effect of potential another round of competitive devaluations. The crisis caused most of East

Asian countries to devalue their currencies against the dollar in order to promote their export, whereas China helped prevent a worse downturn in the East Asian economies, by keeping its currency stable. Instead of risking regional repercussions by out-exporting its neighbours, China tried to stimulate domestic aggregate demand to offset the world economic slowdown. From theoretical point of view, China's effectiveness of fiscal expansion can then be explained by Mundell-Fleming model (1963) of how fiscal policy works in an open economy. Given China's exchange rate, price level and interest rate were relatively stable between 1994 and 1998, thus together with the confidence of no deflationary exchange rate appreciation and tightened capital control, the expansion of domestic aggregate demand was a remarkable success. During a major crisis, this policy limited competitive depreciations among the smaller East Asian economies and facilitated their return to exchange stability in its aftermath (Zhao Zhijun 2001). On the other hand, stationary exchange rate expectations enabled countercyclical fiscal policy within China itself to be more effective (McKinnon, 2002).

## 2.7 Since Asian Crisis

In mid 1999, the IMF classified China's exchange rate regime as a fixed arrangement. Chinese authorities began to ease the restriction on foreign exchange as the effect of the Asian Financial Crisis diminished. In 2001 The ban on the purchase of foreign exchange for past overdue debts repayment was removed and the restrictions on purchasing foreign exchange for advance repayment of domestic foreign currency debts were relaxed (Lin 2003).

In later 2001 the authorities further relaxed the restriction on the foreign exchange system. According to the new policy individuals could convert all their expenses needed for study as long as they are in higher education. Also the foreign exchange authorities decided to relax the requirements for domestic firms to open a foreign exchange bank account. Furthermore, in an effort to control the black market, the authorities adjusted banks' buying and selling rates for the US dollar. In addition, aiming to join WTO the authorities deepened the liberalization of the foreign trade regime which brought the average import tariff down to 15.3 percent.

After more than fourteen years of effort, China was finally accepted by WTO. In order to meet the requirement of accession, China has liberalized its trade and investment policy such as in the area of financial and agriculture sectors. In 2002 it also abolished the differential treatment toward foreign exchange accounts for current international transactions. The new regulation allows all foreign trade firms to open foreign exchange account for current international transactions. Moreover foreign financial institutions were allowed to compete in domestic security markets. And by the end of 2006 there was meant to be a fair treatment between domestic and foreign financial institutions.

There was no timetable for capital account liberalization however. In fact the freeing of capital account was not included in the negotiation of WTO accession. Lin (2003) suggested that this tight control of capital account reflected the authorities' worry about illegal capital flights, macroeconomic instability, and undeveloped domestic financial sector. However, in order to gain modern technologies and skills,

the capital control is mainly on capital outflow, while encouraging inflow. By the end of 2001 the value of China's capital inflows such as foreign direct investment and security investment reached \$600 billion, whereas the outflows were only \$350 billion.

To further liberalize the foreign exchange regime, China needs to undertake a final step, which is to free the capital account. The Chinese authorities learnt the lesson from Asian Financial Crisis however, which is that sufficient preparation must be done. The liberalization of the capital account is more complex than that of the current account since it needs the development of financial markets. Johnston (1997) pointed out that lack of a sound financial system could generate distortions and regulatory incentives for capital movements that are unrelated to underlying economic conditions, thus leading to the instability in capital movement. Greene and Isard (1991) and Mathieson and Rojas-Suarez (1993) emphasized that the importance of prudent fiscal and monetary policy, a market-clearing exchange rate, an adequate level of foreign reserves, and a developed financial system are the preconditions for RMB capital account liberalization.

Lin (2003) suggested two aspects need to reform in financial sector. One is the liberalization of interest rate. However, the liberalization of interest rate could lead to the bankruptcy of low profit state owned enterprises; the chain effect in turn could intensify the strain on the banking system. Another obstacle is the inefficiency of four major state owned banks. These banks account for over 90 percent of total bank assets and 70 percent of all deposits (Shang 2000). Currently the non-performing loans held

by the four banks make up over 20 percent of their outstanding loans. This poor performance of the major banks severely threatens the stability of the financial sector.

McKinnon (1998) stressed that the delay of capital account reforms could also be costly. Thus in China's case the reform of financial sector and turning it into a sound system is a crucial task facing the China's authority currently. Especially since the requirement of WTO accession leads to a direct competition between foreign and domestic financial institutions, the reform seems formidable.

Following the elapse of the negative effects on China's economy brought about by external crisis, the net export and foreign direct investment grew synchronously, which also led the official foreign reserve to accumulate quickly. Sound economic fundamentals and improving ability to withstand financial crisis transformed the initial market expectation of RMB devaluation to expected revaluation. The quoted exchange rate of RMB by People's Bank of China from 2001 to 2005 echoed such a change of market expectation. For instance, in 2001, the fluctuation margins of RMB against US dollar was still maintained within plus minus 1 per cent, the daily quotation of RMB's exchange rate was still undulating around the approximate central rate of 8.2770 Yuan per US \$. However, the situation changed when it stepped into the October of 2004. Since then, the exchange rate of RMB manifested extraordinary rigidity. In the nearly total ten months from 2004 October to July 20<sup>th</sup> of 2005, the daily closing quotation of the exchange rate of RMB almost unchanged pointed to 8.2765 Yuan per US Dollar.

On the day of July 21<sup>st</sup> 2005, China modified its exchange rate arrangement from a

single peg system against US dollar to a basket peg regime against the currencies of its major trade partners<sup>5</sup> (but does not reveal the weighting of component currencies). The external value of RMB was also realigned slightly, from a centre rate of 8.2770 to 8.11 against dollar, which meant a mild revaluation of about 2 per cent. Meanwhile, the fluctuation margins of RMB were also enlarged to  $\pm 0.3$  per cent. It is conspicuous that such a modification keeps the principal exchange rate framework unchanged. But it may be helpful in improving the working mechanism of the RMB's exchange rate and avoiding related risks incurred by pegging against US dollar. From another point of view, if this modification exhibited that the Chinese currency authorities and policy makers had realised the pros and cons of the long lasting external imbalance, then this action should be encouraged. This will be beneficial to the equilibrium of balance of payments and sustainable economic growth of China itself in the medium term, and also to the gradual adjustment of global imbalance in the long run.

## 2.8 Summary

To conclude, since 1979 the political urge to liberalise caused the economic reforms. China had gradually become a market economy country from the one that was controlled by central planning. The exchange reform process in particular took three stages. Firstly it adopted the ISR, thus the dual exchange rate appeared in China. The

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<sup>5</sup> On August 9, 2005, Central Bank Governor Zhou Xiaochuan (2005) disclosed a list of 11 currencies as constituents of the reference basket, he stated that the major currencies in the basket are the US dollar, the euro, the yen, and the Korean won. In addition, the rest of the currencies in the basket are the Singapore dollar, the British pound, the Malaysian ringgit, the Russian ruble, the Australian dollar, the Thai baht, and the Canadian dollar. The governor said that these currencies were chosen because of their economies' importance for China's current account.



second stage of reform shows that because of the trade deficit affecting the economy the authorities adopted foreign exchange swap market instead of ISR. The third round of exchange reform was characterized as exchange rate unification which is to ensure current account convertibility.

In the first round reform the official exchange rate severely undermined the export sector. The authorities used the ISR, export subsidies; foreign exchange retention and export rebate to compensate the loss in export sector. With the overvalued official exchange rate in the mid 80s the authorities introduced swap market to help raise the profitability of the export sector. Furthermore, the government increased the foreign exchange retention ratio to offset the adverse effect of official exchange rate for exporters. In order to join the GATT China embarked on third exchange reform aiming to meet international norms. This reform finally led to exchange rate unification. At last China had the current account liberalization.

Even though, the government control in foreign exchange system is still tight (Lin 2003). The evidence may be given such as transaction verification for import payment and export receipt, and evaluation of exporters' performance in meeting foreign exchange market. Still, China has the tight control on capital account partly because of the Asian Financial Crisis. However, after the accession to the WTO China has to open up the domestic financial markets to foreign investment after all. This seems to be a formidable task for Chinese government to resolve the weaknesses of the financial sector and inefficiencies of the state owned banks.

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## **Chapter 3: An assessment of China's Exchange Rate Policy**

### **3.1 Introduction**

“In the last decade, there has been a hollowing out of the middle of the distribution of exchange rate regimes in a bipolar direction, with the share of both hard pegs and floating gaining at the expense of soft pegs. This is true not only for economies active in international capital markets, but among all countries. A look ahead suggests this trend will continue, certainly among the emerging market countries. The main reason for this change, among countries with open capital accounts, is that soft pegs are crisis-prone and not viable over long periods.” (Fischer 2001)

The above comment by Fisher suggests, as we have seen in the previous chapter, that fixed exchange rates are liable to speculator attacks and it is played crucial negative role in Asian Crisis. Hernandez and Montiel (2001) find that most of the East Asian countries, such as Korea, Indonesia, Philippines, Singapore, and Thailand now have more flexible exchange rate systems than before the crisis. However, China still has a managed pegged exchange rate regime (with permitted fluctuations), the so called managed floating exchange rate. Mckinnon and Schnabel (2002) argue that there are inevitable factors for emerging markets to adopt fixed exchange rate policy despite the objection by IMF. Empirically Mckinnon and Schnabel (2002) found that the fluctuation of East Asian countries' exchange rates is not the sign of flexible exchange rate; rather as the over depreciation during crisis leads to appreciation, there is trend for exchange rates to be pegged against the dollar. Also Hernandez and Montiel (2001) observe that the official foreign reserves in China, Hong Kong, Indonesia, Korea, Malaysia, Philippines, and Thailand have increased surprisingly

fast since 1998. In Korea, Indonesia, and Philippines, foreign exchange reserves accumulation have been far above their pre-crisis levels. The rise in foreign exchange reserves can be seen as an attempt to dampen exchange rate appreciation after the over depreciation during crisis. Furthermore, the reserve accumulation could also support future official interventions to secure dollar pegs. Empirically, countries, such as Singapore, Taiwan, and Hong Kong, who have large foreign reserves have successfully defended their pegs against speculative attacks, or even, prevent the attacks from happening *ex ante*. This implies that emerging countries are fit enough to sustain fixed exchange rates. However, the literature offers little by way of consensus on the viability of exchange rate regimes for emerging markets apart from highlighting the advantages and disadvantages of specific cases.

In this chapter we mainly focus on the literature in two respects, first in why emerging markets are so prone to adopt fixed exchange rates. We focus on this point from a theoretical perspective. Second, we review the literature on currency China's exchange rate regime, and the discussion of its future exchange rate regime.

### 3.2 Why fixed exchange rate regime?

There are several reasons to adopt a fixed exchange rate regime, among them all, perhaps the nominal anchor argument for monetary policy is of most interest by academic economists. The argument is first derived from a closed economy case by Kydland and Prescott (1977), who show that the central planner has a time inconsistency problem when they conduct monetary policy. There can be inflationary bias when monetary policy is fully discretionary. Nominal anchor is just based on the

idea that discretionary policy can cause central planner's inflationary bias, and pegging currency to a relatively low inflation country may prevent domestic government from building inflation bias, thus ensuring price stability. The implication of adapting a nominal anchor for the exchange rate is as follows: assuming capital is relatively mobile, a nominal peg to US dollar, say, indicates targeting the US interest rate. An expansionary policy in domestic country would widen the interest differential between domestic and foreign country, and entail inflow of capital putting appreciation pressure on the value of domestic currency. Since exchange rate is fixed, a central bank has to sell domestic currency in the international financial market. By doing so, the ex ante expansionary monetary policy is sterilized. In effect, a nominal anchor 'imports' monetary discipline and low inflation by requiring that the central bank follow the monetary policy of another country. Nominal anchor mainly concerns the price expectation by individuals. Therefore, with nominal anchor, individuals would expect low inflation in the future because the currency peg will prevent the central planners from expanding money supply even if they wanted to. Thus a country with a nominal anchor can attain a lower level of inflation for any given level of output.

Since the nominal anchor approach works through the individual's expectation of inflation, an obvious criticism of nominal anchor is whether the announcement of fixed exchange rate is credible. Mishkin (1999) points out that accountability is a problem for many central banks in emerging markets. If central banks lack credibility, then fixed exchange rate may be worse than floating exchange rate, since floating

exchange rate can at least play a key indicator of the stance of monetary policy. Obstfeld and Rogoff (1995) note that from the currency speculator's perspective it is questionable that any pegged regime is truly credible. They also observe when capital mobility is high, even if there is no danger of a balance of payment crisis, government's pledge to defend against large scale speculative attack is not credible. Frankel (2003) also stresses that speculators know that the harm caused to domestic investment and bank solvency by interest rate hikes employed in defence of fixed parity often has political costs severe enough to make the defence unsustainable. Frankel (2000) and Cottarelli and Giannini (1997) also show that even with currency board arrangement, in which the exchange rate is fixed by law and backed by foreign reserves, currency boards are unlikely to anchor expectations if law is not respected or authority cannot be delegated. In the case of China's exchange rate, the revaluation in July 2005 implies that the credibility of this fixed exchange rate regime is no reliable. The fact that 'revaluation fears' have appeared regularly in the financial press, and that policymakers have had to promise repeatedly that the RMB will remain 'stable', reveals some of the insecurity with which market participants view the policy. Moreover, as an anchor for inflationary expectations, the policy can hardly be credible while China's capital controls extend the authorities space for monetary discretion. Even if the authorities made the peg official by announcing buying and selling rates for the currency, it is unlikely that this would improve the policy's credibility, given the China's central bank nearly complete subordination to political authority, and its lack of financial accountability. Another crucial factor for nominal anchor to work is

the unexpected shocks to which foreign monetary policy responds are the same from those faced by the pegging country. Obstfeld and Rogoff (1995) note, that by giving up the monetary policy, domestic central planners lose their ability to respond to external and domestic shocks with monetary expansion or contraction policy. Although fiscal policy is enhanced when there is fixed exchange rate as suggested by the Mundell-Fleming model, empirically fiscal policy has transmission lags and lengthy administration costs.

Another reason of fixed exchange rate adoption is derived from game theory; the outcome of fixed exchange rate is the result of Nash Equilibrium. International trade normally constitutes a major part of GDP in emerging markets. Therefore, fixed exchange rate can prevent competitive depreciation. Frankel (2003) stresses that fixing exchange rates can be an efficient institution for achieving the cooperative solution. He also observes that each time one country in East Asia or Latin America devalued, its neighbours were instantly put at a competitive disadvantage, serving to transfer the balance of payments pressure to them (e.g., from Mexico to Argentina in 1995, from Thailand to the rest of East Asia in 1997, and from Brazil to the rest of South America in 1999). However, the devaluation did not work, when its competitors were devaluing at the same time. Thus a cooperative agreement not to devalue may seem reasonable.

A third reason for the exchange rate to be fixed is that high exchange rate variability would create uncertainty, which would discourage international trade and investment. By fixing the exchange rate to its major trade partner can then eliminate

exchange rate risk and transaction costs, and thus encourage investment and international trade. There is some debate on this argument. First, any intervention by government in exchange markets is a distortion in theory; exchange rate uncertainty is merely the symptom of variability in economic fundamentals. Second, given the existence of future and forward market, any exchange rate variability can be hedged away in international trade. Third, empirically there is no clear evidence indicating that exchange rate uncertainty shows adverse effect on international trade. These arguments seem debatable if we consider emerging markets. Many developing countries have no sophisticated forward or future market, and even where they do, the transaction cost and exchange risk premium on hedging are costly. Also most empirical evidence on the relationship between exchange rate variability and international trade are based on industrial countries. The recent econometric studies find strong evidence of an effect of exchange rate variability on trade based on developing countries (Frankel 2003). Calvo and Reinhart (2002) also use data set on a worldwide scale and find that exchange rates in developing countries are less volatile due to heavy dependence on international trade, and interest rates and financial reserves are much more volatile than in industrial countries. They conclude that emerging markets have so-called “Fear of Floating” properties. Reinhart (2000) concludes that:

“The root causes of the marked reluctance of emerging markets to float their exchange rates are multiple. When circumstances are favourable (i.e., there are capital inflows, positive terms of trade shocks, etc.) many emerging markets

are reluctant to allow the nominal (and real) exchange rate to appreciate. ...

When circumstances are adverse, the fear of a collapse in the exchange rate comes from pervasive liability dollarization. Devaluations are associated with recessions and inflation, and not export-led growth.”

Calvo and Reinhart (2002) argue that there are two aspects explaining fear of floating. First, as we argued above, fixed exchange rate can anchor one country's price level.<sup>6</sup> Second, volatile capital flows could affect nominal exchange rates and because the domestic price level is relatively sticky, it will lead to large changes in a country's real exchange rate. Its international competitiveness could fluctuate sharply.

“Original sin” is another reason for fixed exchange rate argued by Eichengreen and Hausmann (1999). “Original sin” is defined as a situation in which the domestic currency cannot be used to borrow abroad or to borrow long term. Their empirical studies on emerging markets shows that all domestic investments have either a maturity mismatch- long term investments financed by short term loans, or currency mismatch- investments using domestic currency financed by foreign currency. This problem is mainly due to the case that external liabilities are necessarily denominated in foreign exchange which is unable to hedge because of incompleteness and fragility of domestic financial markets, such as the forward market. In order to offset the non-existent future or forward exchange, the government is induced to provide an informal hedge when borrowing abroad by keeping the exchange rate fixed to major currencies. Domestic banks can then repay their foreign debts and minimize exchange

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<sup>6</sup> Especially as China have high percentage of international trade invoiced in US dollar (Mckinnon 2002).



rate risk. McKinnon (2001) notes that if a country's financial markets are condemned by original sin, its regulatory authorities have strong incentives to undertake exchange rate pegging in order to mitigate payments risk.

### 3.3 Current exchange rate policy and currency revaluation

In this section we review the literature on current China's exchange rate policy and look at its possible future policy on exchange rate. In previous chapter we have seen that after July 2005 China officially adapted a new exchange rate policy; instead of pegging purely to US dollar, RMB is targeting a basket of currencies<sup>7</sup>. However, central bank does not reveal the targeting weight on currencies. The secrecy of targeting basket triggers a wave of postulation on the weight of basket currencies. The empirical studies on this topic examine whether China's authorities really let the exchange rate policy move towards more flexibility.

Shah, Zeileis, and Patnaik (2005) consider only four major currencies in the RMB basket (US dollar, the yen, the Euro, and British pound) using data only the initial few months after July 2005, and found that RMB is still tightly pegged to no other currencies except the US dollar. Frankel and Wei (2006) and Ogawa (2006) found that RMB exchange rate policy in the second half of 2005 was still a tight fixed exchange rate solely on dollar using a list of 11 currencies as constituents of the reference basket. Eichengreen (2006) use daily data from July 22 2005 to March 2006, and found that 90 percent of the weight in RMB currency basket is still US dollar, there is

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<sup>7</sup> There is a list of 11 currencies as constituents of the reference basket, the major currencies in the basket are the US dollar, the euro, the yen, and the Korean won. In addition, the rest of the currencies in the basket are the Singapore dollar, the British pound, the Malaysian ringgit, the Russian ruble, the Australian dollar, the Thai baht, and the Canadian dollar.

not significance on other currencies.

All the above studies used data before mid 2006, whereas Yamazaki (2006) used up to date estimation and found there are considerable weights on Euro, Japanese Yen and Korean Won. His estimation however is in terms of levels rather than changes on the weight and the trend of basket weight, and had a relatively small number of observations.

Frankel and Wei (2007) allow for evolution of China's exchange rate regime since July 2005, and divided the sample into six approximately equal size periods. They found that the first six months after the announcement of exchange rate regime change by China's authorities, the RMB still heavily pegged to US dollar which is indistinguishable from a dollar peg. Since February 2006, the weight in the basket was shifted to other currencies, such as the Malaysian ringgit, the Korean won, the Russian rubble, and the Thai baht, but no evidence of positive weigh to the Japanese yen and Euro. However, the weight on US dollar is still 0.9.

To summarize, there was very little change in the fixed exchange rate regime within 2005. Not only did the true weight on the dollar in the basket remain close to 1, but the tightness of the fit was similar to that of the Hong Kong dollar, which is on a currency board. In 2006, the de facto regime began to put a significant, but still small, weight on some non-dollar currencies.

Is the current exchange arrangement adopted by China right, or not? China is now categorized by IMF as a country having a conventional pegging system, which means

China belongs to one of the middle group of exchange arrangements<sup>8</sup>. Since the issue about the exchange rate and regime of RMB was initially put on table by international institutions IMF in the January of 2003, the debate over this issue has continued unabated. This led to an abrupt influx of the literature on the valuation and policy of the Chinese currency. A large number of interesting articles has touched upon this issue from various perspectives. However, the economists have not reach consensus on two points: the degree of the undervaluation of RMB and the time and steps to adjust the current exchange regime of China.

Robert Mundell (China Daily 2003) argued that the pegged exchange rate regime works well for China. He also criticized the IMF: “There’s never before in history (or never been a situation) that international monetary authorities ... try to press a country with an inconvertible currency to appreciate its currency.” He suggests that fixed exchange rate is still in the interest of China as long as capital account is not fully liberalized, as the appreciation of exchange rate will lead to deflation pressure as in the period of Asian Crisis<sup>9</sup>. Mostly importantly there will be negative impact on Foreign Direct Investment (FDI) and export sector, which will hurt GDP growth as these two sectors are the main contributions for GDP. However, Jeffrey Frankel<sup>10</sup> (2004) pointed out, “China, for one, is too large a country to dollarize or adopt a currency board, but is probably not ready for pure floating either. That leaves intermediate regimes<sup>11</sup>, either the current adjustable peg, on the one hand, or

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<sup>8</sup> On public occasion, the Chinese government declares its exchange arrangement is a ‘Managed Floating’ system.

<sup>9</sup> Given the current situation in China where inflation is the major concern for government, this may promote exchange rate appreciation in the present time.

<sup>10</sup> Written for a High-Level Seminar on Foreign Exchange System, Dalian, China, May 26-27, 2004.

<sup>11</sup> See Frankel 1999 paper for his identification of exchange rate regimes.

alternatives such as a target zone, centred either on the dollar or on a basket, on the other hand”. Conversely, if the exchange arrangement that China is pursuing at the moment is compatible with its economic fundamentals, should China perpetuate this exchange rate regime? Eichengreen (2003) argues that the fragility of China’s banking system and immaturity of the capital market are not excuses for maintaining a pegged exchange rate regime. He suggests that China’s authorities should abandon the US dollar peg and adopt a floating system. However, the revaluation of the RMB would certainly influence the international foreign exchange market since purchases of US government bonds by China’s authorities are one of most important ways that US finances its trade deficits. Some Chinese scholars, such as Yu (2004), paid more attention to the exchange rate regime than to the adjustment of the exchange rate alone. They admitted that there was pressure for Chinese exchange rate to appreciate, and suggested that the China’s authorities work hard towards a more flexible exchange rate regime, instead of simply adjusting the level of the exchange rate. However, regarding the timing of the adjustment, it was thought that the best time to adjust would be when the RMB has no attraction for speculators, in other word to avoid speculative attack. Li Gang-Liu (2004) suggested that the central bank should allow the RMB to target US dollar in a wider range.

IMF (2004) and some other academics like Funke and Rahn (2004) concluded that “there is no strong evidence that the Renminbi is substantially undervalued”, such an opinion soon submerged in a sea of working papers that held the opposite viewpoint. Based on a variety of models and approaches such as traditional balance of payment

equilibrium, absolute or relative Purchasing Power Parity, general equilibrium models and some other simulation exercises, plenty of distinguished versions of predictions of the 'fair' value of RMB had been made.

Many economists use PPP to examine the level of RMB. Funke and Rahn (2004) use the simple "Big Mac index" and "Starbucks Latte index" to examine the level of RMB. "Big Mac index" in April 2003 shows that RMB was undervalued by 56 percent. According to the "Starbucks Latte index" however shows RMB was undervalued by only one percent as of 2004. Single commodity price comparison approach has its own limitations. Kanamori and Zhao (2006) argue that the big difference may be explained by the degree of penetration of the commodity into the domestic market. Thus, it may be that the Big Mac has become quite common for ordinary PRC people and has to compete with other traditional foods, while Starbucks Latte is still uncommon, and may be an exclusive commodity that cannot be substituted by traditional commodities, and therefore is basically priced based on overseas prices.

The simple PPP approach, although simple and easy to understand, has this bias. It has been well recognized that PPP does not hold in short run, even in long PPP is not a good indicator for emerging market due to its market incompleteness. Goldstein (2004) and Goldstein and Lardy (2003) consider China's current account, capital account and GDP growth, using balance of payment equilibrium method, found that RMB was severely undervalued by 15 to 30 percent. They also argue that China's authorities intended to manipulate their currency in order to gain competitive

advantage in international trade. They then suggest currency reform for China's authorities in steps. Firstly for the interest of international community and the advice from IMF, RMB should appreciate to its equilibrium level, without liberalizing capital account and adopting floating exchange rate. They suggest that China's exchange rate policy could appreciate RMB by at least 15 percent, widening the margin around the fixed exchange rate and switch from a US dollar peg to a basket peg. China's exchange rate policy can finally reach managed floating rate with liberalization of capital account unless China's banking system and financial market especially financial hedging instrument such as forward and future market, becoming relatively stronger.

Williams (2003) argue that it would be better off for China's authorities to adjust their exchange rate at one time rather than divided into steps. His suggestion is based on the expectation of market participants. He notes that the adjustment should be significant enough to convince market participants that the change was complete and that there would be no second step, since otherwise a revaluation might simply lead to more speculative attack through capital inflow.

Bergstein (2003) suggested a single-step revaluation of the RMB by 20 to 25 per cent. The RMB trade weighted average exchange rate had been depreciated by 10 percent and driven the dollar down against all other currencies since 2000. He compares the RMB exchange rate policy with other historical even and argues that China's fast growth of current account surplus and overheated domestic economy can be regarded as classic signs of substantial currency undervaluation. He then illustrates

the example of Japanese economic bubble following the Plaza meeting, and emphasizes that the bubble and the following economic collapse was due o Japanese yen undervaluation. Thus in short run China's exchange rate policy is to revaluing the RMB, which would help China to reduce its massive trade surplus and stabilize the domestic price level. The sooner the revaluation the more likely to avoid an inflationary bubble that would eventually burst and curtail growth.

Wren Levis and Benassy-Ouere (2004) use quarterly data and Behavioural Equilibrium Exchange Rate (BEER) approach found that the RMB to US dollar should adjust to 6.5, which mean an appreciation of 28 percent, in order to restore current account equilibrium<sup>12</sup>. They also estimate bilateral equilibrium exchange rate, and found real equilibrium exchange rate stay the same since 2001, which means China's exchange rate was undervalued by 47 percent in 2003.

Barry Eichengreen (2004) suggested that a modest appreciation for RMB on the order of 5 to 10 per cent will be appropriate for the current economic conditions facing China. Beside these estimates, the *Economist* (2003) radically implied that the exchange rate of RMB against US dollar was undervalued by nearly 56 per cent in terms of the Big Macs index. Two economists from Western Connecticut State University, Zhang and Pan (2004), accommodated the variables like the inflation differential, the long-run movement of the real exchange rate and the government intervention into their model of exchange rate estimation. According to their estimation, the exchange rate of RMB should have appreciated by 15 to 22 per cent in

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<sup>12</sup> They found that appreciation would be even larger if the objective were to balance both current accounts and capital flow in China.

2003 relative to the year 1996 without government intervention. Chang and Shao (2004) even proposed an exact number of 22.5% undervaluation in the exchange rate of RMB, with a *P*-value of 0.286.

Hughes-Cromwick (2003) points out that it is difficult to estimate the RMB misalignment because as in other emerging countries, data availability and reliability and capital controls would lead big difference between the results found through different approaches. Also “determining the fair value of a currency is difficult, particularly when there are major structural changes that are almost impossible to model. China’s case is arguably more difficult than most other cases, precisely because of the scale and speed of the structural changes that have been taking place<sup>13</sup>.” They summarise all the empirical studies on the RMB and conclude that the range of the RMB undervaluation was somewhere from 5 to 30 percent.

Although the strand of economists who had undertaken the technical calculation of the ‘equilibrium’ value of the RMB declared that there were clear evidence showing the RMB was undervalued, most of them did not agree that a swift revaluation would resolve the underlying problems facing China once and for all. For example, Goldstein (2004) instead proposed that “China should take a ‘two-step’ currency reform”, switching from a unitary US dollar peg to a basket peg for the first step and then transiting “to a ‘managed-float’, along with a significant liberalization of China’s capital outflows” for the second. Eichengreen<sup>14</sup> (2004) also argued that “what is needed is not a big step revaluation but a shift to a new regime in which China is

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<sup>13</sup> ‘The Case for a Stable Chinese RMB’ by Morgan Stanley economist Stephen L. Jen

<sup>14</sup> Prepared for the Asian Economic Panel, Hong Kong, April, 2004.



better able to tailor local financial conditions to local needs”.

From a long-run perspective, a managed floating or freely floating exchange arrangement will be unarguably a better choice for China than the current peg. Friedman (1953) point is that “exchange rates adjust much faster than domestic prices and quantities, making this insulation all the more valuable, remain a potent one.” Floating exchange rate has its own advantage in that is it acts as the buffer against external shocks. If there is positive shock exchange rate will appreciate and vice versa.

Most importantly the floating exchange rate gives the monetary authority the independence to respond to domestic and external shocks. Chinn and Miller (1998) argue that since developing country normally has incomplete bond market, monetary policy is always better than fiscal policy. Empirical studies (Edwards and Savastano, 1999) also suggest that the evidence of effectiveness of nominal anchor in fixed exchange rate is inconclusive.

Adopting an exchange rate regime with greater flexibility would remove the constraints that had been put on the authorities’ monetary policy autonomy, improve the economy’s ability to stand up with internal and external shocks and reduce the volatility that frequently haunted the economic activity. However, the realities in China’s economy at present are rather stranded. A floating exchange rate regime implicitly requires both goods and capital to freely flow. Obviously, China should relax its strict regulation on capital flows once it allows the exchange rate of RMB to float freely. This is not too much different from a ‘Big Leap’ at such a moment, when

the exchange rate of RMB is still pegged against a basket of currencies and the capital flows are still under control. In addition, much empirical experience has shown that it may be too risky to allow cross-border capital to flow freely while maintaining a hard pegged exchange rate regime. Thus, China seems to face a dilemma. The way out for China may be the last resort i.e. gradually adopting an exchange arrangement with more flexibility and finally allowing the exchange rate to freely fluctuate at an appropriate time with the removal of control on capital movements. The appropriate timing depends on China's economic fundamentals and its trade and financial integration with the rest of the world.

After China's accession to the World Trade Organization (WTO) in 2001 coupled with its promise to further open domestic financial market from the end of 2006, it is reasonable to believe that the integration of China's economy with the outside world is accelerating. If China wants to enjoy the bliss brought about by the flexible exchange arrangement, some preparations must be done now.

In fact, the philosophy of gradualism also won much support from quite a few prominent academics although they may diverge in choosing what kind of transitory regimes and dealing with the sequence of opening capital account and adjusting exchange arrangement. With the help of capital controls, limited exchange rate flexibility will prompt domestic enterprises and financial intermediations to care more about the fluctuation of exchange rate and encourage them to employ more advanced financial skills and instruments, which had been already developed by industrial economies, to hedge the currency exchange related risks. The increased sensitivity to

exchange rate fluctuation and more hedging instruments will in turn facilitate the development of domestic capital market and foreign exchange market. If so, this will lay a solid foundation for the Chinese economy before removing the restrictions on its capital account step by step and finally transiting to a flexible exchange rate regime.

### 3.4 Outstanding Costs of Maintenance of Current Peg

#### 3.4.1 Stylized Facts of China Growing Trade and International Reserves

Figure 3.1 shows China's import and export over the past two decades. From 1978 to 2004, the import and the export measured in US dollars has grown from 10.89 and 9.75 billion, to 561.23 and 593.33 billion respectively, amounting to an annual average growth rate of nearly 17.5% and 17.7%.

Figure 3.1 China's Import and Export: 1978-2004.

Source of data: National Bureau of Statistics & Ministry of Commerce of the People's Republic of China. Official Website: [www.mofcom.gov.cn](http://www.mofcom.gov.cn)

**Note:** The right-hand scale applies to Net Export only.

In contrast to the steady progress of imports and exports, the net export growth great volatility. Between 1978 and 1990, China's net export appeared in surplus in only two years -- 1982 and 1983, and a typical boom-bust cycle existed. Such a

situation only changed after 1994, when the foreign exchange policy reform was put into effect. Since then, the net export began to show a persistently upward trend, and a current account surplus lasted in the following years until to date.

The foreign reserves held by the central bank of China were also rapidly increasing. (See Figure 3.2). In the 1980s, the maximum amount of foreign reserves kept by the People's Bank of China never reached 10 billion US dollars. Since 1994 reform, however the foreign reserves began to grow exponentially. Particularly in the three years to 2005, the foreign reserve rocketed up. In 2002, China's foreign reserve was about 286.41 billion.

Figure 3.2 Growth of China's Foreign Reserve: 1979-2005.

Source of data: State Administration of Foreign Exchange of China.  
Official Website: [www.safe.gov.cn](http://www.safe.gov.cn)

US dollars, but it became 403.25 in 2003. In 2004, it jumped even higher, to nearly 610 billion dollars. In the first nine months of 2005, such an explosive growing trend kept running on. By the end of September, the foreign reserve reached its historic recorded top -- more than 760 billion US dollars, which is almost one and a half times more than its concurrent total value of import.

In 1994, China reformed its exchange rate regime. This reform did achieve significant successes in many aspects: the soaring inflation rate was pulled down, from a rate of 24.2% in 1994 to 16.9% in the following year and finally to a nearly 1% deflation in 1998 after the outburst of Asian crisis (see Figure 3.3); at the same time, Foreign Direct Investment (FDI) and the foreign trade increased substantially. However, the negative impacts on the economy were also becoming increasingly protrusive due to the changed economic situations. Such a model of stimulating economic growth by maintaining a fixed exchange rate to stabilize domestic price, reduce the uncertainty, attract foreign investment and increase export to pull up the employment growth, is creating for China much more costs than benefits.

Figure 3.3 Yearly CPI Change of China: 1987-2004.

*Source of data: IMF International Financial Statistics, Nov 2005*  
*Data Access Provided by Economic and Social Data Service (ESDS)*

### 3.4.2 Constraints on Monetary Operation

With the increasing of foreign reserves in the central banks balance sheet, the People' Bank of China is facing mounting pressures. The space left for the PBC to

manoeuvre its monetary policy instruments is being squeezed away little by little.

On one hand, to keep the ex ante exchange rate system running well, the central bank is forced to frequently intervene in the foreign exchange market to buy the excessive supply of foreign currency. Without offsetting operations, this will lead domestic monetary base to expand remarkably. The pressure of this kind on the central bank is undoubtedly huge. Figure 3.4 shows the changing position of central bank held foreign reserves from 2002 to 2005. We can see that, the ratio of foreign reserves to the central bank's total asset has climbed from about 0.4 in the first quarter of 2002 up to nearly 0.6 in the third quarter of 2005. Even though only half of these increased reserves is sterilised, the undue increment of monetary base is still considerable.

Figure 3.4 Quarterly Ratio of Foreign Reserve to the Total Asset of the Central Bank of China.

On the other hand, to avoid the negative impacts of over expansionary monetary supply on domestic economy, such as the subsequent investment impulse and inflation soaring, the central bank has to take some inhibitive measures to curfew the excessive growth of domestic credit, either through raising interest rate, or by increasing the reserve requirement or through open market operations.

However, to raise the interest rate, it will instantly stimulate the perceived profit motives of international speculators. At the present moment, it is generally believed that the control on capital outflow is more effectively fulfilled than that on capital inflow in China. Obviously, increasing the interest rate will intrigue more speculative money to get around the capital controls and ultimately form domestic supply of foreign currency. Either partly or fully sterilising this money, the pressure on domestic money supply will only grow up rather than climb down. This will eventually undermine the efficacy of the interest rate as an optional instrument of monetary operations.

Moreover, domestic regulatory authorities of banking sector also find it lacks other more effective instruments to harness domestic loan expansion while maintaining an already very low baseline interest rate, except for strengthening some non-interest rate measures like 'window guidance' or additional administration. This, in turn, will increase the administration cost and will also hamper the effort to marketwise domestic interest rate, which is an objective that the Chinese authorities has been long pursuing. In any way, interest rate has no substantial role to play under the framework of using exchange rate as a nominal anchor.

In like manner, there is also no unshakable reason to believe the sterilisation process can be pursued unlimitedly. With the mounting up of official holding of foreign reserve, the underlying costs of sterilisation go up substantially. In 2004, to avoid pouring oil on the already flammable domestic price, the central bank reinforced the strength of open market operation to offset the soaring foreign reserve by selling a large quantity of central bank bills to domestic commercial banks. In the same period, the data collected by IMF shows the baseline interest rate in China is about 3.3 per cent, the deposit and loan rate are respectively 2.25 and 5.58 per cent. If domestic commercial banks do not diversify their acquired deposit asset to the central bank bills that only pay the base interest rate, they can gain a higher marginal profit. Nevertheless, because of the substantive involvement of the government in domestic state-owned banks and its huge leverage on them, the banks were forced to accept the central banks' offers. It does make much difference for banks whether to lend to commercial clients or to engage them in the central bank bills.

In addition, facing a weak discount rate (the baseline rate) of US dollar since 2001, which is only 0.75 per cent in 2002, 2 per cent in 2003 and nearly 3.15 per cent in 2004, it has little doubt to believe that even the People's Bank itself was losing its position on the present financial grounds. It implies that the central bank is paying the bill for playing the sterilisation game, and this will finally form the implicit fiscal burden.

### 3.4.3 Increasing Exposure of Banking Sector

The banking system in China is almost commonly thought of as one of the systems



that potentially has the greatest risk. Weak institution, discounted supervision, underlying moral hazard and amassing non-performing loans (NPL), any of these weak points can give the Chinese banking sector a fatal strike. Whereas, in a fixed exchange rate regime, these weakness are often masked and even neglected. Although some Chinese officials have expressed in public occasion that the overall exposure of banking system to the exchange rate risk remains controllable, there are indications that such an exposure is rising.

In China, the banking deposits account for a dominant portion of the overall sources of financing in China. The banking institutions intermediate a substantive proportion of new financing. In the past three years, the domestic deposits continue building up. The data of People's Bank manifests that, since the end of 2002, the ratio of the total deposits to the overall funds sources, which include all kinds of domestic deposits, securities and the circulated currencies, has been almost constantly above 90%. And the ratio of the sum of domestic money and quasi money (M2) to Gross Domestic Product has risen from nearly 160% in 2002 to more than 172% in 2004. This is very remarkable, particularly for an emerging market economy.

However, in ironic contrast to its dominating position in domestic financing, the operating performance of the Chinese banking institutions appears to lag far behind. The up-to-date reality is that the big four state-owned commercial banks holds roughly more than a half of the banking assets, and almost all of them face the tricky issue of non-performing loans. For almost decades, the ratio of the NPLs that originated from the Big Four state banks had never dropped below 90%. Even in

March of 2005, the authorities could only manage to reduce this ratio to 86%. The detailed break-down of current distribution of the non-performing loans across domestic banking institutions is shown in Figure 3.5.

Figure 3.5 Distribution of Non-Performing Loans in Different Domestic banking Institutions by September 2005.

Source of data: The China Banking Regulation Commission.

Official Website: [www.cbrc.gov.cn](http://www.cbrc.gov.cn)

By September of 2005, according to the statistics of the China Banking Regulatory Commission (CBRC), the overall non-performing loan is nearly 1.28 trillion Yuan using the 5-tier loan classification system. It is approximately equal to 158 billion US dollars and account for about 10 per cent of GDP. A note that must be given here is that this result was achieved just after two of the Big Four banks, the Bank of China and the Construction Bank of China, transferred 33.9 billion US dollars of non-performing loans between June and July of 2004 to the designated Asset Management companies. This is not the first time for the Big Fours to sell off their NPL. To utterly remove the issue of NPL is not as easy as ever imagined, particularly in China's banking system on which the government has a great influence.

Figure 3.6 Ratio of the Non-Performing Loans of State Commercial banks to the Total Banking Loans

Source of data: The China Banking Regulation Commission.

Official Website: [www.cbrc.gov.cn](http://www.cbrc.gov.cn)

Since 2003, the NPL ratio seemed embarking on a generalised downward trend (see Figure 3.6). But no sufficient evidences show that the non-performing loans have been substantially cut down. If observing that the bank lending in recent years is also climbing up simultaneously, it is not difficult to understand what happened behind the splendid data. Before the authorities would like to slack its rope on the state commercial banks and transform the Big Fours into modern banks that can operate independently to pursue profit, self-constraint to lower risk and strengthen internal reforms to compete, the final effect of current administrative measures to dispose the non-performing loans remains worth doubting.

#### 3.4.4 Exacerbating Price Distortion and Misallocation of Resource

In recent years, China has been keen on shooting for other countries' admittance of its market economy status. Of course, in comparison with the situation two decades ago, it is undisputable that China is striding towards a modern market economy and

has achieved a lot in this respect. However, even now, it is not rare to see the phenomena of price regulation and transformation, and halfway price transmission in China. The governments, central or local, still have great leverages in the economic activities, and the state enterprises still dominate the economy. The power of market remains limited so far. There is still large space left for China to deepen its marketisation reform further.

Firstly, let's focus our attention on domestic oil sector, particularly on the oil price. Since 2003, the international crude oil price began to step hand over hand. Whereas, in satiric contrast, the domestic wholesale and retail price of finished oil product looked almost insusceptible. Even after the State Development and Reform Committee granted the domestic retail and wholesale petrol price to float up slightly in March 23<sup>rd</sup> of 2005, the average retail petrol price among the 35 main cities in China was just above 4 Yuan, less than 0.5 dollar per litre.

In 1998, the central government had tried to align domestic oil price with a composite index of the finished oil product prices in New York, Amsterdam and Singapore. But the oil price is now still under the government's regulation in actuality. The price setting mechanism percolated unwanted disturbance of external oil price swing to domestic economy, nevertheless, coupled with the weakening dollar and soaring oil price, the potential costs for China -- the second largest consumer of oil product around the globe, is unarguably considerable.

So far so good, the two largest state energy enterprises, China National Petroleum Corporation (CNPC) and China Petroleum & Chemical Corporation (CPCC), appear

tolerant of the current situation, although the domestic oil price has not soared as much as the international oil price. However, it is very clear that the profit of domestic energy enterprises is being crushed. There are also indications that the restrictions on domestic oil price are surrendering the downriver enterprises such as refinery plants and oil transporters to lose little by little. In addition, due to the over-low domestic petrol price, most oil refiners prefer exporting their finished product to selling domestic customers. This has led to insufficient domestic supply of petrol in some coastal areas.

If the price distortion in the oil price cannot be removed, it will probably endanger domestic energy supply and even jeopardize the economic growth at last. In addition, with the swift expansion of domestic automobile industry and the speedy increase in the number of private cars, the pressure to keep domestic petrol price low is ascending. It will be in great question if China can withstand the lumping shock brought about by a sudden let-go of domestic oil price in the near future.

Until now, the price setting rule in domestic oil product did work. However, in contrast to the abstentious oil price, the real estate price in China is really dazing, especially in the 35 main cities. According to the data of NBSC, only in the first quarter of 2005, the retail house price has ascended by 9.8% in these main cities. In Shanghai, the most attractive place for foreign funds, the house price goes up even higher, a jump of nearly 20%. Behind the soaring prices, it is not difficult to see the trail of international hot money. According to the statistics of the PBC's Shanghai branch, the weight of foreign funds flowing into the real estates of Shanghai is 16.1%

in 2001, up to 23.5% in 2003 and above 25% in 2003. In the first five months of 2004, this proportion has ascended to 32.6%.

The reason that the hot money chooses China as their speculative object cannot be explained without touching the ex ante exchange rate arrangement once more. The most convincing explanation so far refers to the strong expectation of RMB revaluation. In addition, it is also undeniable that the loose domestic monetary condition and the downturn of domestic equity market add fuel to this fire. As soon as the current exchange rate regime continues operating, it is almost impossible to entirely block off the speculative attack on RMB of hot money. If the authorities don't want to lose control over domestic property price while maintaining current exchange arrangement in operation, harsher restrictions and punishments have to be exercised. This will inevitably incur more administration cost and efficiency loss.

Furthermore, the already invited risk by the hot money is not too intangible to ignore. Massive break-in of international speculative capital creates not only potential bubbles in the real estate market, but also a great amount of potential non-performing loans in the banking system under the circumstance that about 60% of housing investment comes from the bank loans<sup>15</sup>. This will pose new challenge to the attempt of domestic banks to keep the non-performing loans under control and will also affect the stability of domestic financial system indirectly. If the government decided to adjust the exchange rate, then, the possible outcome such as bubble burst and the disruptive ruin of fund chain even the financial crisis must be well combed out.

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<sup>15</sup>Statistical Data from China International Capital Corporation Ltd.

### 3.5 Disquiet on Moving towards a More Flexible Exchange Rate Arrangement

Albeit the growing criticism of China's export-led growth model, so far the economy seems to be working well: the trade and FDI are increasing, the economy is growing and the job opportunity is also aggrandizing. So a natural question will arise if China adjusts the ex ante exchange rate – will all these good fortunes reverse?

On account of the large share of import and export in the Gross Domestic Product, the trade is widely regarded as the linchpin of current prospering economic development and employment growth of China. If the RMB is allowed to appreciate, people will be naturally worrying about the possible negative effects on the trade sector, like the external competitiveness, the trade position, the profits of trade companies and the employment environment etc. However, it is also not gratuitous to believe that the negative shocks to the economy of a slight appreciation will be mitigated to some extent if we notice the structural features of the trade industry of China.

Due to the preferential policy that the Chinese government adopted since 1978 to attract Foreign Direct Investment, the foreign-owned enterprises in China has boomed largely. According to the data from the Ministry of Commerce, the accumulative total number of foreign enterprises that were officially approved was approximately 512,504 by the January of 2005. These enterprises have brought in China a total amount of fund exceeding 566 billion US dollars. Most of the foreign enterprises are distributed along the coastline in the east part of China, where the infrastructure, like

swift transportation and advanced communication, is more favourable. Except for some high-tech products that China cannot produce and some kind of products that may be more popular in China, a large proportion of the products manufactured by foreign enterprises are again exported to the overseas markets.

Moreover, the weight of foreign enterprises in China's total exports was also ascending. In 2004, the foreign enterprises exported more than 338.6 billion dollars of product, which accounted for 57% of total export; the weight of import share by foreign enterprises was 57.8%, a value worthy of 324.6 billion dollars. Among the foreign enterprises in China, the formidable multi-national companies occupy the dominant position. The entry of foreign multi-nationals into China's trade industry makes the link of domestic production of trade goods with the rest of the world even closer.

Meanwhile, the internationalization of production chain resulted in a high quotient of import contents in the exports of China. According to Lau (2003), the domestic value-added content of China's exports only occupied a proportion less than 30 per cent. Besides, the capital goods, raw materials and semi-manufactured goods but not the consumption goods make up the bulk of China's imports. The imports of these kinds have low sensitivity to price. Therefore, the impacts on the trade incurred by the 'expenditure switching' of a little bit stronger RMB are believed low: a more valuable RMB will cut down China's exports, but will also make the imports even cheaper.

In addition, the concern also exists in the corporate sector, particularly in the companies undertaking export. Under the current situation that China's export



accounts for almost more than 40% of GDP, the negative effects on the export companies of the appreciation of RMB is evident. A slight, even a tiny revaluation of exchange rate will narrow their already very low profit margins, and probably lead some of them to close down. However, a conclusion of this kind can only be drawn from a short run perspective, and the effect should not be exaggerated. “The share of private domestically owned firms in total exports is still less than 10 per cent<sup>16</sup>. And, insofar as a large share of export content takes the form of imported component even for private domestically owned firms, changes in the exchange rate affect both costs and revenues in the same direction and therefore do not give rise to severe financial difficulties<sup>17</sup>.”

In the long run, adjustment of RMB exchange rate may create more opportunities. A moderate revaluation will wash out some profitless enterprise, turn away inefficient low-level competition and optimize the allocation of resource on one hand; on the other hand, it will also prompt the enterprises to increase investments, strengthen the research and development and use more advanced technology. Thus, it will not only make domestic enterprises more competitive, but also speed up the reconstructive and upgrade of domestic industries. In addition, facing the possible risks of exchange rate volatility, the enterprises will spontaneously take advantage of currently available hedging skills and instruments to shun away such currency related risks. Thus, it will also accelerate the improvement of domestic foreign exchange market. In a nutshell, there is no intolerable sacrifice that is needed to stand up by the enterprises while

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<sup>16</sup> According to the NBSC data, this share has increased up to 17% in 2004. It is 13.7% in 2003.

<sup>17</sup> “Chinese Currency Controversies”, Barry Eichengreen, April 2004.

facing a moderate exchange rate appreciation.

Another concern is that an upward adjustment of the RMB exchange rate may affect the in-flow of Foreign Direct Investment (FDI) significantly. Despite the common argument that it is the current low-valued RMB that makes China more attractive to FDI, so far, there is little evidence of being able to link the level of exchange rate with the FDI flows convincingly. The level of FDI flowing into a country is mostly determined by the factors such as economic prospect, market size, and rate of return to investment, labour cost, productivity growth, macro environment and interrelated regulation, and not by the exchange rate. As for China, the fundamentals to attract FDI are undoubtedly strong while checking against these rules. Given the affluent labour resource, the swiftly improving productivity and the far-reaching access to the world market, there is no persuasive evidence showing that a moderate upward adjustment of RMB rate will entomb the flourishing FDI into China.

In like manner, some worries exist in China's banking system, too. The foreign assets and liabilities of banks will also change correspondently once the exchange rate of RMB changes. The varying margins will be finally reflected in the balance sheets of banks, and will inevitably affect the profit in the banking sector. But the final effect will depend on the net foreign asset position of domestic banks. So far, available evidence tends to manifest that the impacts of a slight revaluation of RMB on domestic banks are minor.

Since the central government re-valued the currency on July 21 of 2005, the stock

price performances of several domestic publicly listed banks, like Shanghai Pudong Development Bank, Shenzhen Development Bank and Huaxia Bank, were rather stable. The following quarterly financial reports of these banks were not much affected. The balance sheet effects of RMB revaluation on these banks seemed not as amazing as ever estimated. As for the big four state commercial banks, such a slender exchange rate shock is also believed to have limited impact because the weight of net foreign asset in the total asset of these four banks is still low.

In addition, it will be too rash and incomplete simply departing from the aggregate statistical data before we have an extensive and intensive investigation on the asset-liability structures of individual domestic bank, such as maturity of liabilities and securities, currency composition. And, we are not yet very sure about if any possible active effects on the asset quality of domestic banks could be generated and spoilt over by adjusting the exchange rate of RMB.

Finally, because most of the foreign exchange transactions have to go through domestic banking institutions at the moment, the domestic banks have more opportunities to practice foreign currency management and develop more products of foreign exchange to shield away foreign exchange related risks. Accordingly, the sensitivity and ability of domestic banks to deal with the risks of these kinds are relatively higher while comparing with other sectors, although the categories and products of hedging instrument that can be chosen by domestic banks are still limited. Thus, the effect on domestic banking sector of a tender revaluation will be bounded and a controllable process of adjusting RMB exchange rate will be a sensible choice

for China.

### 3.6 Summary

Although China's economy has benefited a lot from fixed exchange rate arrangement, it seems that it needs a more flexible exchange rate policy when China opens its financial market. As for now, the soaring financial reserve accumulation has already shown its side effect- domestic investment overheating, inflation rate rising, and most importantly neutrality of monetary policy. As factor prices are raised in the world market, such as steel, oil, corps etc, the urge to revalue RMB is apparent. Sooner or later, the economy will embark on path of self-adjusting. China had better take the initiative than be forced to do so. Empirically, when looking back at the history of China's exchange rate in the past decades, it is just a dynamic process of continual innovations and reforms.

To conclude, the literature on China's exchange rate regime has not reached a consensus. The reasons why most of emerging countries are so prone to adapting fixed exchange rate are theoretically viable. Nominal anchor, Fear of Floating, Original Sin and other factors seem reasonable theoretical defence for fixed regimes. However, empirical studies are inconclusive. As for China, the revaluation in July 2005 seems to renege from the commitment of fixed exchange rate. This will negatively affect the credibility of the RMB, and possible attract a speculative attack. In general, economists argue the RMB is more or less undervalued by range from 5-30 percent. However, the theoretical models such as PPP used on empirical studies

are different and may not be valid for emerging market. The data availability and viability is also a concern for most of emerging markets. It seems reasonable therefore that there is still a debate on whether China's exchange rate regime is suitable in present time. But one thing is certain: in the long run a floating exchange rate is the ultimate goal given the liberalisation of capital account and sophisticated financial market.

## Chapter 4      Theoretical Analysis: A Dual Exchange Rate Model

### 4.1 Introduction

This Chapter focuses on whether the current exchange rate regime in China should be made more flexible, and the property of such more flexible regime in stabilising external shocks. To cater for the specific situations in China, a dual exchange rate model, in the spirit of Flood and Marion (1983), is developed. Such a model can also be used as a framework to organise conflicting views regarding how exchange regime in China should be reformed.

A *de jure* and *de facto* dual exchange rate system have been operating in some countries, like Belgium and Luxembourg, for a long time after the second world war while co-existing among the dominant Bretton Woods system. However, relevant theoretical literature on this hybrid of a purely floating and a hardly pegging exchange arrangement did not emerge until the early 1970s, when two of the industrialized countries, France from 1971 August to 1972 May and Italy from the January of 1973 to the March of 1974, implemented the dual exchange rate scheme to shield their economies away from external shocks resulted from frequent capital flight between countries. Since Fleming published one of his articles on dual exchange rate in 1971, his followers, like Argy and Porter (1972), Sheen in (1974), Lanyi (1975) and Dornbusch (1976) and Steinherr et al (1976), have individually stated their views to analyse the mechanism and outcome of the dual exchange rate system.

The setup of a dual exchange rate system can be thought of as the result of countries that need to deal with the risks caused by disruptive international capital movements

but also want to keep certain control over the exchange rate management and the magnitude of fluctuation of exchange rate at the same time. For those countries that are exposed to highly volatile international capital flows but still want to take advantage of some merits of a fixed parity exchange system, it proves to be an effective measure to put the dodgy capital movements under control. 'Control' can take in the form of either direct Quantitative Restriction (QR), or indirect fiscal interventions such as taxes or subsidies affecting capital transactions, or a dual exchange arrangement, or other macro guides through economic policy operation.

As in this sense, the system of dual exchange rates and the system of hard peg but with capital controls are juxtaposed together for comparisons and analyses. After deliberate research and careful considerations of the comparison of these two regimes, Adams and Greenwood (1984) said, "The adoption of a dual exchange rate system turns out to be equivalent to levying a tariff on financial transactions with the rest of the world. Furthermore, dual exchange rate systems and systems of capital controls are isomorphic to one another in the same sense that tariffs and quotas are identical in the standard trade literature."<sup>18</sup> In their paper, they also demonstrated how the implementation of a dual exchange rate system is parallel to a government levying taxes on private capital transactions and how QR is analogous to imposing quotas on private financial transactions. One point that must be made here is that the working mechanism and channels of these two exchange arrangements to affect the net capital flows may be slightly different: the dual exchange rate system influences the capital

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<sup>18</sup> IMF paper, received July 1983, revised version received June 1984.

movements through *ad valorem* taxes or subsidies that will affect the price difference between domestic and foreign assets but the quantitative restriction measures determine the capital transactions by limiting the quantities of traded assets. In spite of this, an undisputed fact is that, “in most cases, they operate in the same manner as taxes to restrict transactions in one direction without operating (as subsidies do) to encourage transactions in the opposite sense.”<sup>19</sup> (Fleming, 1974)

The standard argument for a dual exchange rate regime assumes that the exchange transactions of goods and capital are segregated and channelled into two categories of markets: one for current account transactions and the other for capital account transactions. In such a system, a majority of imports and export transactions assigned with higher priority by the government are settled in the official foreign exchange market; a tiny proportion of other current account transactions with lower priority and all the capital transactions are settled in the financial exchange market. A prototype of the dual exchange market system is usually assumed with a pegged official exchange rate, or in other name the commercial rate, and a freely adjusted financial exchange rate. The government holds foreign reserves to maintain the official exchange rate but the financial rate is mainly determined by market force. As a consequence, when compared with the unified flexible exchange rate regime, the dual exchange arrangement can, to some degree, avoid the potentially excessive instability of exchange rate and the begotten disturbance to trade flows; and when compared with a purely fixed exchange rate regime, it gives the currency authorities

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<sup>19</sup> See Marcus Fleming 1974, IMF Staff Papers.



some space to wield monetary policy by removing the pressures on foreign reserves caused by cross-country capital flights.

In a dual exchange rate system, the changes in financial exchange rate influence the international capital flows by exerting impact on two separate motives of expected returns to traded securities: one is the “rate of return motive” and the other is the “capital gains motive”<sup>20</sup>. The first motive stems from the fact that the interest payments earned from the foreign assets are settled through current account channel. This means the effective return on foreign assets depends not only on the foreign interest rate but also on the spread between the commercial and financial exchange rate. If we denote the commercial exchange rate as  $e$  and the financial rate as  $s$ , then the domestic effective interest rate must be equal to  $(e/s) \cdot i^*$ , where  $i^*$  represents the foreign interest rate. The spread between these two rates immediately creates a premium or discount on the interest payment obtained from foreign assets. The second motive is more directly affected by the expected changes in the financial exchange rate, which will reversely determine the expected capital gain or loss on domestic claims on foreign assets. A change in the financial exchange rate can lead the formation of expectation of the future movement in financial rate in both directions. Specifically speaking, a rise in the financial exchange rate above the commercial rate can be followed either by a further upward increase or by a downward ‘correction’. This will lead the desired domestic holding of claims on foreign assets to roll up or cut off.

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<sup>20</sup> See Anthony Lanyi 1975 IMF Staff Paper

However, a successful dual exchange rate system implicitly calls for a strict or at least effective separation of markets, though it may even require a perfect segregation in theory. Or else, the government intervention may be an inherent requisite to maintain such a dual exchange system in operation because the spread between the commercial rate and the financial rate will incur massive speculative arbitrages or illicit evasion, which may in turn lead these two rates to diverge from each other even further and disequilibria and at worst to destroy the dual exchange system.

In this chapter, following prior studies in the literature we adopt the assumption that a perfectly separated dual exchange rate regime operates. With such a rule in place, a natural conclusion can be drawn that such a dual exchange market immediately “chokes off all net capital movements into and out of a country adopting the regime”<sup>21</sup>. (Flood, 1977) The reason is not too hard to comprehend. In such a system, it is still free for domestic residents to trade the internationally issued securities e.g. like the consol-type bond. However, to purchase the foreign securities, only two choices eventually face the desired demand. In the first case, the domestic resident can buy the securities directly from another domestic resident who want to sell its claims on foreign assets without involving foreign exchange. This will actually lead the domestic securities to change hands only among domestic residents. In the second case, a domestic resident can pay foreign exchange to foreign sellers for the securities. But this will necessitate the domestic resident to own foreign exchange first. Facing a purely segregated capital market from the goods market, the only source of

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<sup>21</sup> See Robert Flood 1977 paper, Journal of International Economics.

foreign exchange supply can come from an exactly opposite sale of the securities by another domestic resident. These parallel transactions in contrary directions immediately cancel off any net capital movement between this country and the rest of the world. In either case, there will be no net capital flow crossing the border.

Finally, the fulfilment of entirely segregated dual exchange markets will have the following impacts on the economy: although the individual can change the constitution of his or her asset portfolio, the domestic residents as a whole cannot alter their net claims on the foreign assets; the economy can only alter its net wealth through the central bank by means of trade surplus or deficit. In addition, the implementation of such kind of dual exchange arrangement can also bring some potential losses to the whole economy. First, such an arrangement in place will hamper the free flow of capital across borders and thus lead to efficiency loss; second, it will incur interest rate differentials between countries and lead to distortion and misallocation of resources.

After reviewing the market structure and the operating mechanism of the dual exchange rate regime, we discuss a specific model, which is based mainly on the paper of Flood and Marion (1983). In this paper, the two authors analyzed and, to some extent, explained the behaviour of Italian lira during the implementation of a dual exchange scheme between 1973 and 1974 by virtue of a model of transitory exchange arrangement. We hope the historic experience obtained from the Italy's case could shed some light on the understanding of the exchange rate dynamics that characterizing the operation of the current system in China.

## 4.2 Theoretical Model and some Key Equations

A dual exchange rate system such as a fixed commercial exchange rate but a flexible financial rate and perfectly separated markets applies to the model. In addition, the domestic residents are implicitly assumed to have made the best of all the information available to them at each time point to form their expectation about the future movement of the financial exchange rate.

In this model, the supply of domestic goods is assumed to be constantly maintained at a level of  $y_t = \bar{y}$ , and the demand and supply for any of goods are in equilibrium. The foreign currency price of goods  $p^*$  is exogenously fixed and no barrier to trade is imposed. The constantly held commercial exchange rate  $e$  determines the domestic price of goods  $p$ , which also determines the partition of domestic output between domestic consumption and the country's export. The arbitrage between the good markets of home and the rest of the world will keep the Purchasing Power Parity held:

$$p_t = e_t + p_t^* \quad (4.1)$$

On the asset sector, only two types of financial assets are considered: domestic money and an internationally traded but foreign issued consol-type bond. The domestic money is exclusively held by domestic residents and the bond can be traded across the border. The accumulation of domestic holding of the consol-type bonds immediately represents an increase in domestic net claims on foreign assets. The world value of domestic holding of the consol-type bond is  $k_t$  at time  $t$ . The internationally traded bond yields a rate of return of  $i^*$ , which is fixed by assumption

and repatriated to the home country by the rest of the world at the commercial exchange rate. Putting the two channels affecting the expected yield on foreign securities together, then, the opportunity cost of domestic money holding at a time point can be characterized by:

$$i_t = i_t^* + \alpha \cdot (e_t - s_t) + \dot{s}_t \quad (4.2)$$

where  $\alpha$  is a parameter relying on the spread between the financial and commercial rate with a strictly positive value.

The domestic money market is in equilibrium. The domestic real money supply  $m_t^s - p_t$  is equal to domestic real money demand that is a function of domestic real income and the opportunity cost of money holdings:

$$m_t^s - p_t = \beta_1 \cdot y_t - \beta_2 \cdot i_t \quad (4.3)$$

where  $\beta_1 > 0$  and  $\beta_2 > 0$ .

The central bank balance sheet links the domestic monetary base with the foreign reserve  $f$  and the domestic credit  $d$ :

$$m_t^s = \omega \cdot f_t + (1 - \omega) \cdot d_t \quad (4.4)$$

where,  $0 < \omega < 1$ , i.e. the nominal domestic monetary base is a weighted average of the foreign reserve component  $f_t$  and the domestic credit component  $d_t$ .

On the side of domestic saving and wealth accumulation, let  $w$  denotes the total domestic marketable asset. It consists of a portion  $\theta$  of domestic money supply  $m$  and the rest portion  $(1 - \theta)$  of domestic nominal value of the domestic held bonds  $s + k$ . Deflated by the price index, the domestic real wealth can be expressed as:

$$w_t = \theta \cdot m_t + (1 - \theta) \cdot (s_t + k_t) - p_t \quad (4.5)$$

where,  $0 < \theta < 1$ .

The identity that links domestic real wealth accumulation with the planned savings of domestic residents can be specified by:

$$\dot{w}_t = \gamma_1 \cdot (y_t - w_t) + \gamma_2 \cdot (i_t - \dot{p}_t) \quad (4.6)$$

where  $\gamma_1 > 0$  and  $\gamma_2 > 0$ , because the behaviour of planned saving of domestic residents is positively affected by both the output-wealth ratio and the real interest rate.

So far, we have completed the description of the model. However, to derive a solution from this model, some additional conditions must be clearly specified:

1. The commercial exchange rate is fixed at  $\bar{e}$ .
2. The Purchasing Power Parity holds, so the domestic price level is fixed once the foreign price level  $p^*$  is given. In this case,  $\bar{p} = \bar{e} + p^*$ .
3. The domestic capital market is perfectly separated from the goods market, so the stock of domestic holding of foreign bond is unchanged once the dual exchange system is implemented. Thus, we have a constant stock of bond  $\bar{k}$ .
4. The domestic component of monetary base  $d$  is a variable exogenously determined by the government. Without government led expansion or contraction of domestic credit,  $d$  will not change. The change in domestic monetary supply will be a sheer result of variation in foreign reserve.

Therefore,  $d_t = \bar{d}$  and  $\dot{m}_t = \omega \dot{f}$ .

Before studying the dynamics and the effects of the shocks, the Appendix A

provides a background to the development of the Mundell-Flemming open economy model, which the author studied prior to the development of the above model. The above model and the phase diagram analysis to understand the dynamics can be better understood by providing a background to the analysis, covered in the Appendix A.

### The Dynamics of $s$ and $f$

Substituting equations (4.2) and (4.4) into (4.3), equation (4.3) can be rearranged as:

$$\dot{s} = \alpha \cdot s_t - \frac{\omega}{\beta_2} \cdot f_t + G \quad (4.7)$$

where  $G = (\beta_1 \cdot \bar{y} - (1 - \omega) \cdot \bar{d} + p^* + \bar{e}) / \beta_2 - i^* - \alpha \cdot \bar{e}$ . This schedule has vertical-axis intercept  $-G$ , and it is upward-sloping.

In such a dual exchange scheme, according to equation (4.5), the variation in domestic real wealth can be characterised as:

$$\dot{w}_t = \theta \cdot \dot{m}_t + (1 - \theta) \cdot (\dot{s}_t + \dot{k}_t) - \dot{p}_t = \theta \cdot \omega \cdot \dot{f}_t + (1 - \theta) \cdot \dot{s}_t \quad (4.8)$$

In addition, substituting equations (4.2), (4.4) and (4.5) into (4.6), the change of real wealth caused by the planned saving behaviour of domestic residents is:

$$\begin{aligned} \dot{w}_t = & \gamma_1 \cdot (\bar{y} - \theta \cdot (\omega \cdot f_t + (1 - \omega) \cdot \bar{d}) - (1 - \theta) \cdot (s_t + \bar{k}) + p^* + \bar{e}) \\ & + \gamma_2 \cdot (i^* + \alpha \cdot (\bar{e} - s_t) + s_t) \end{aligned} \quad (4.9)$$

Putting equations (4.7), (4.8) and (4.9) together, the dynamics of the government official reserve can be shown by:

$$\dot{f}_t = -\frac{(1 - \theta)(\alpha + \gamma_1)}{\omega \cdot \theta} \cdot s_t - \left(\gamma_1 + \frac{\gamma_2 + \theta - 1}{\theta \cdot \beta_2}\right) \cdot f_t + H \quad (4.10)$$

where 
$$H = \frac{(\gamma_2 - 1 + \theta) \cdot G + T}{\omega \cdot \theta}$$

$$T = \gamma_1 \cdot [\bar{y} + \bar{e} + p^* - (1 - \theta) \cdot \bar{k} - \theta(1 - \omega) \bar{d}] + \gamma_2 \cdot (i^* + \alpha \bar{e}).$$

Because the coefficient before  $\dot{f}_t$  in the schedule  $\dot{f}_t = 0$  can be either negative or positive, the slope of  $\dot{f}_t = 0$  schedule is uncertain. Put the differential equations (4.7) and (4.10) in a matrix system (See Appendix B) as below:

$$\begin{bmatrix} \dot{s} \\ \dot{f} \end{bmatrix} = \begin{bmatrix} \alpha & -\frac{\omega}{\beta_2} \\ -\frac{(1-\theta)(\alpha+\gamma_1)}{\omega \cdot \theta} & -(\gamma_1 + \frac{\gamma_2 + \theta - 1}{\theta \cdot \beta_2}) \end{bmatrix} \cdot \begin{bmatrix} s \\ f \end{bmatrix} + \begin{bmatrix} G \\ H \end{bmatrix} = A \cdot \begin{bmatrix} s \\ f \end{bmatrix} + b \quad (4.11)$$

Here we get the determinant of matrix A :

$$\det A = \begin{vmatrix} \alpha & -\frac{\omega}{\beta_2} \\ -\frac{(1-\theta)(\alpha+\gamma_1)}{\omega \cdot \theta} & -(\gamma_1 + \frac{\gamma_2 + \theta - 1}{\theta \cdot \beta_2}) \end{vmatrix} = -\alpha \cdot \gamma_1 - \frac{\alpha \cdot \gamma_2 + \gamma_1(1-\theta)}{\theta \cdot \beta_2} < 0$$

Therefore, this system shows immediate saddle-path stability, with roots  $\rho_s < 0$  and  $\rho_u > 0$ . The stable eigenvalue  $\rho_s$  corresponds to the stable eigenvector  $v_s$ .

Then, it must satisfy:  $(A - \rho_s \cdot I) \cdot v_s = (A - \rho_s \cdot I) \begin{bmatrix} v_1^s \\ v_2^s \end{bmatrix} = 0$  i.e.

$$(\alpha - \rho_s) \cdot v_1^s - \frac{\omega}{\beta_2} \cdot v_2^s = 0. \text{ Let } v_2^s = 1, \text{ then } v_1^s = \frac{\omega}{\beta_2 \cdot (\alpha - \rho_s)} > 0. \text{ This means the}$$

unique stable saddle-path has a positive slope that is not contingent on how the  $\dot{f}_t = 0$  schedule behaves.

In addition, the condition of  $\det A < 0$  implies that the slope of schedule  $\dot{f}_t = 0$  is smaller than that of schedule  $\dot{s}_t = 0$ . Let  $f^e$  and  $s^e$  denote the stationary levels of financial exchange rate and foreign reserve. The linear approximation to system (4.11) around these levels can be arranged as follows:

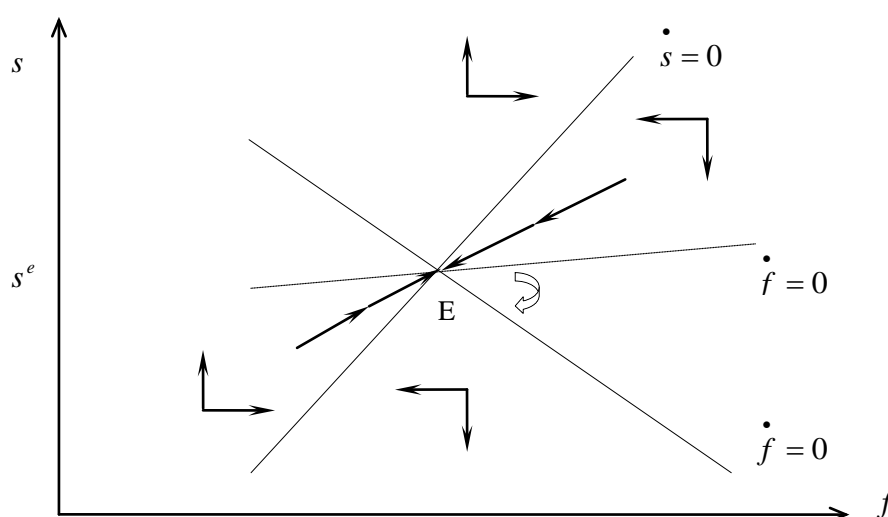


$$\begin{bmatrix} \dot{s} \\ \dot{f} \end{bmatrix} = A \cdot \begin{bmatrix} s - s^e \\ f - f^e \end{bmatrix} \quad (4.12)$$

where  $\begin{bmatrix} s^e \\ f^e \end{bmatrix} = -A^{-1} \cdot b$

The qualitative solution to this dual exchange rate system is shown in Figure 4.1, where the saddle-path slopes upward from left to right through the equilibrium point  $E$  in  $(f, s)$ -space. Because the economy is self-stabilizing with an adjustable financial exchange rate and a variable foreign reserve, then, it will converge to the equilibrium point at last, no matter where the economy starts from. Given the assumption that the foreign reserve adjusts slowly, it is the financial exchange rate that has to jump in response to the nominal or real shocks shifting the saddle-path, and then moves towards the new equilibrium point along the new saddle-path.

Figure 4.1 The dual exchange rate phase diagram



In this graph, the arrows show the directions of motion of both  $s$  and  $f$ . To the left of the  $\dot{s} = 0$  locus,  $\dot{s}$  is positive and is thus rising; above the  $\dot{f} = 0$  locus,  $\dot{f}$

is negative and is falling. Both  $s$  and  $f$  evolve over time to satisfy the conditions that individually characterize domestic monetary market dynamics (Eq 4.7) and relate domestic residents' planned saving to wealth accumulation (Eq 4.10). For any positive initial level of  $f$ , there is a unique initial level of  $s$  matching on the stable saddle-path. The economy then moves along the saddle path to the point  $E$ .

### 4.3 Implications of the Model

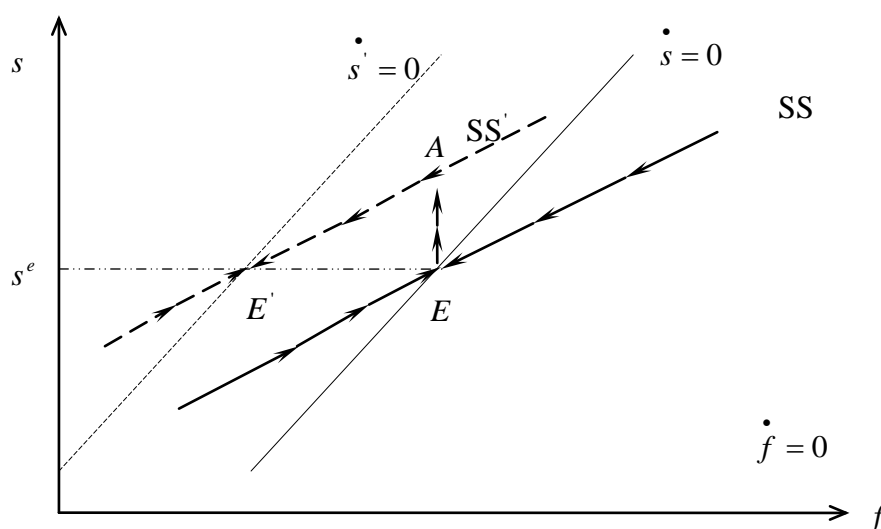
#### 4.3.1 The Effects of Domestic Credit Expansion

First, let's consider the effect on the dynamics of  $s$  and  $f$  of a permanent domestic credit expansion from  $d$  to  $d'$ , which means the proportion of foreign reserve in the total money supply,  $\omega$ , declines. It can be derived that the decrease in  $\omega$  will shift the  $\dot{s} = 0$  locus upward to the new schedule  $\dot{s}' = 0$ . In addition, using system (4.12) and differentiating  $f^e$  and  $s^e$  with respect to  $\omega$  respectively, we can get that  $\partial f^e / \partial \omega > 0$  and  $\partial s^e / \partial \omega = 0$ . The results mean that, the equilibrium level of foreign reserves  $f^e$  is monotonically increasing in  $\omega$ , but the change of  $\omega$  has no effect on the stationary financial rate  $s^e$ . As a result, in the long-run, a permanent increase in domestic credit will lead the foreign reserves to decline, but leave the financial exchange rate unchanged. Figure 4.2 describes the dynamics of an economy facing expansionary credit shock.

Assume the economy is initially located in equilibrium point  $E$ , through which the original saddle path  $SS$  passes. In response to a permanent expansion of domestic credit, both the foreign reserves and the financial exchange rate need to change

accordingly. This will induce not only a shift in the  $\dot{S} = 0$  curve to up but a shift in the stationary point from  $E$  to  $E'$ , where the long-run foreign reserve is cut down but the steady level of financial exchange rate remains unvaried.

Figure 4.2 The effects of a permanent expansion of domestic credit

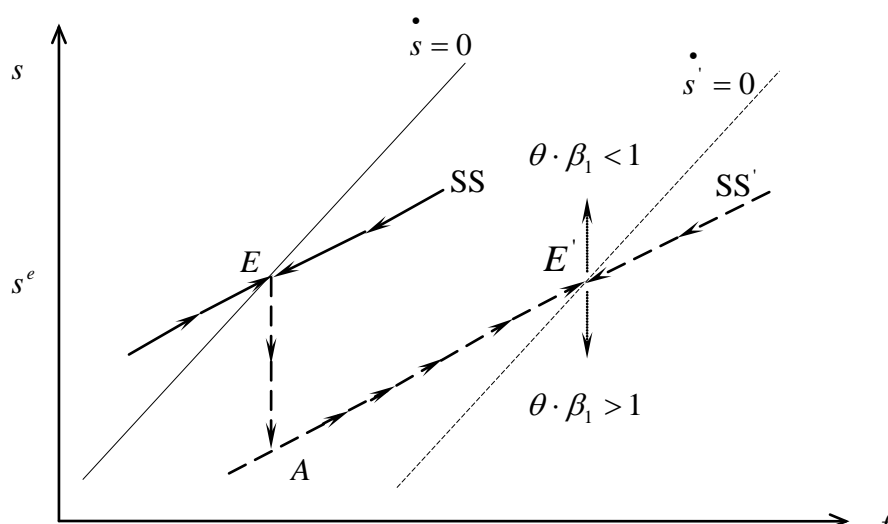


However, in the short run, because the foreign reserves are predetermined and it takes time for them to adjust, the economy's immediate response to such an unanticipated money shock is entirely different, i.e. the financial rates jump up directly from  $E$  to point  $A$  so that the economy can embark on the new saddle path  $SS'$ . Thereafter,  $s$  and  $f$  adjust gradually along the new saddle path  $SS'$  to the new long-run equilibrium point  $E'$ . Thus, the net effect of a permanent domestic credit expansion is that the financial exchange rate initially overshoots and then comes back to its original level in the long run, and the final equilibrium level of foreign reserve decreases.

### 4.3.2 The Effects of Output Movements

Now we consider the effect of an increase in aggregate output. Equation (4.7) implies that output increase will shift the  $\dot{s} = 0$  locus rightward. In the meanwhile, we can work out that  $\partial f^e / \partial \bar{y}$  is greater than 0, which means the output expansion will inevitably lead the long-run foreign reserves to go up. As for the sign of  $\partial s^e / \partial \bar{y}$ , it depends on the product of the income elasticity of money demand  $\beta_1$  and the proportion of money holding in domestic residents' total wealth  $\theta$ .

Figure 4. 3 The effects of a permanent expansion of domestic output



The response of the financial exchange rate to output expansion depends on  $\theta \cdot \beta_1$ . If  $\theta \cdot \beta_1 < 1$  (or  $\beta_1 < 1$  because of  $\theta < 1$ ), the financial exchange rate will depreciate in the long run. If  $\theta \cdot \beta_1 > 1$ , the financial exchange rate will appreciate either in the short run or in the long run. The economy's response to a permanent output expansion is depicted in Figure 4.3.

From above figure, we can see that an increase in domestic output moves the equilibrium point rightward from  $E$  to  $E'$ ; meanwhile, the saddle path also switches

from  $SS$  to  $SS'$ . Domestic output expansion affects not only the long run foreign reserves, but also the long run financial exchange rate. The increase in output leads to the expansion of foreign reserves.

In addition, without government intervention, the increase in foreign reserves will cause the real domestic money supply to increase one for one. If the money demand increase cannot catch up with the increased money supply (i.e.  $\beta_1 < 1$ ), then, it will lead the financial exchange rate to depreciate in the long run. Conversely, the shrinkage of output will lead the foreign reserve to dwindle, and long run financial rates to appreciate if  $\theta \cdot \beta_1 < 1$  and to depreciate if  $\theta \cdot \beta_1 > 1$ .

Therefore, in a dual exchange rate regime, the foreign reserve will move in the same direction as the output change. But the new equilibrium financial exchange rate will depend on the particular structural parameters.

#### 4.4 Summary

The model presented above takes into account the two-tier exchange rate system that is appropriate to the situation in China, and attempts to examine the consequences of a range of policy changes. Particularly, this model was used to investigate two cases: domestic credit expansion and output movements, representing nominal and real shocks. The results deduced from the model are, to some extent, in line with other theories of exchange rate. For example, the effects of domestic credit expansion based on this model are not much different from the one we obtain from Krugman's model (1979) of first generation speculative attack. In both cases, domestic credit expansion will lead foreign reserves to decrease and generate pressure on the exchange rate to

get devalued.

By virtue of this model, we can also analyze the effects of other kinds of macroeconomic shocks, like the variances in foreign goods price  $p^*$  and foreign interest rate  $i^*$ . Besides, the dynamics of foreign reserves and the financial exchange rate caused by the portfolio adjustment that are subject to domestic residents' planned saving behaviour can also be analyzed. This model manifests flexibility by allowing us to examine the effects of any combinations of the accommodated variables. However, there are also some points we do not cover in the model. First, we only analyze the effects of permanent changes in domestic credit and output. But the impacts on the economy of temporary economic policies also deserve attention at times. Second, while discussing the effects of output movements, the case of  $\beta_1 < 1$  is restrictive and the prerequisites that determine the short-run dynamics of financial rate need to be further specified.

Another feature of the model, to contrast in the spirit from the Flood and Marion's model (1983), is that, the two-tier exchange rate model is represented in the transition from fixed but adjustable exchange rates. The general assumptions between the model of this Chapter and the Flood and Marion's model are similar, which include the monetary sector, saving sector, foreign-exchange rate market sector, prices sector and exogenous variables conditions. The difference between them are that the Flood and Marion's model focus on three exchange rate solutions: the two-tier float (TTF) solution, a fixed commercial rate (TT) solution, and the uniform flexible exchange rate regime (FLEX) solution, to represent semi-reduced forms of money-market

equilibrium and planned saving behaviour. Whereas the model of this Chapter focuses on one exchange rate solution, which is a fixed commercial rate (TT) solution to analysis the effect of real stock of wealth. Because the fixed commercial rate (TT) solution provides a framework to investigate the underlying working mechanism and the policy implication, it is particularly appropriate for those regimes with some degree of capital control.

The Flood and Marion's model is based on the assumption that the market will set exchange rates so as to eliminate expected speculative profits at the time of transition, to indicate that expectations of a transition, combined with uncertainty about the nature of the post-transition regime, can cause a jump in exchange rates at the moment of transition as well as volatile exchange rate movements prior to the transition. By contrast, the dual exchange rate model can clearly show how domestic macroeconomic policies and real stock of wealth affect the economy with dual exchange rates. Also it shows how such an economy responds to the external shock brought about by either international capital flows or trade flows. Although, in practice, the effects of implementing segregated exchange markets for current and capital transactions are limited, and the dual exchange rate regime is often used as a transitional arrangement, while facing an accelerating integrated international capital market, understanding the pros and cons of a dual exchange rate economy do bring us useful hints, especially on how to effectively deal with the increasing exposures to the capital flows across countries without entirely giving up the benefits of a fixed exchange rate regime.

## **Chapter 5 Research Methodology and Empirical Analysis**

### **5.1 Introduction**

The objective of this chapter is to provide the method and tools by which the research generates empirical evidence relating to the case for greater flexibility of China's fixed exchange rate policy. The research proposes relevant hypotheses and demonstrates a case for misalignment and support for greater Chinese real exchange rate flexibility by assessing its relative impact on the trade balance.

In chapter 4, a general theoretical model of exchange rate determination was developed to show how the exchange rate interacts with the inflation rate, interest rate and balance of payments, as well as some other exogenous technical and preference parameters. This model is nonlinear, and clear expressions of the model's solutions are usually not available.

However, some special forms of the model have been studied qualitatively. For example, in the case of small countries and constant output (ignorance of the production sector), Shi Kuan Chen (2004) demonstrated that the exchange rate is endogenously determined and the fluctuation of the exchange rate depends on the preference parameter of consumers. Under some specific conditions, exchange rates perform smoothly and a long-run steady state can be achieved, but at a certain time the exchange rate may change explosively. However, the theory itself does not tell us what the shocks are or where the preference parameters are. Thus, how the exchange rate reacts in response to shocks is an issue of empirics rather than theory, which is tackled in this chapter in order to test specific hypotheses.



The rest of the chapter is organized as follows: Section (5.2) presents three hypotheses that are to be tested. Section (5.3) presents the methodology to be used and discusses the data collection process. Section (5.4) discusses the empirical model and variables that will be employed. And the statistical tools (selection the lag length, units root test, cointegration test) to be used to analyze the data and generate results are presented in section (5.5). Empirical results from the Structural VAR model (impulse response function and variance decomposition) are analysed in section (5.6). Further analysis of indicators of real exchange rate movements is discussed in Section (5.7). And finally, section (5.8) concludes.

## 5.2 The Hypotheses

This Chapter examines whether there is a significant relationship between the real exchange rate and real-GDP, whether there's a significant impact of the inflation rate of China/US on the real exchange rate, and whether there is a significant relationship between the real exchange rate and trade-openness ratio. Four fundamental hypotheses are developed to test these relationships between the above variables.

Several studies in developed countries revealed that there is a highly significant response of real exchange rate to relevant shocks. Compared with studies on industrial countries with flexible exchange rate system, Eichenbaum and Evans, (1993) and Clarida and Gali, (1994), found that the response for demand/nominal shocks are most important factors, especially in the long run, and supply/real shocks are as important as in accounting for real exchange rate fluctuation during both short run and long run,

however, the case in China is different for specific reasons as their currencies are pegged to the US Dollar before 2006.

Therefore the four hypotheses are:

**H1: There is a negative relationship between the Real Exchange Rate and Consumer Price Index of China**

**H2: There is a positive relationship between Real Exchange Rate and Consumer Price Index of US**

**H3: There is a negative relationship between Real Exchange Rate and Real GDP**

**H4: There is a positive relationship between Real Exchange Rate and Trade-Openness**

### 5.3 Methodology and Data Collection

To test the above hypotheses, this study employs a quantitative approach using secondary data. Time series data for China are documented in the China Bureau of statistics published quarterly.

The quantitative approach is represented by econometric analysis. Ultimately, the structural VAR model that is going to be estimated will take the following form:

$$Y_t = \sum_{i=1}^n A_i Y_{t-i} + \mu_t \quad (5.1)$$

Where :  $Y_t$  is the vector of endogenous variables

$A_j$  is the matrix of coefficients

$\mu_t$  is a vector white noise process

$i$  is the number of lags

In this test,  $Y_t$  consist of quarterly series of real exchange rate (REER) with domestic and foreign inflation rates (CPIa, CPIc), trade-openness ratio (TRADE), and real-GDP (GDP) separately over the period (1994:1-2005:4). The data sources are International Financial Statistics (IFS) June 2005 edition, China Statistical Yearbook 2004, and China Statistical Bureau. The author takes the two countries to be the U.S. and China. In principle, it would be preferable to consider China vs. the rest-of-the-world. However, data considerations, plus the fact that the misalignment debate revolves around the U.S.-China nexus, motivate us to adopt this perspective.

The vector of endogenous variables can be written as:  $Y_t = [\text{GDP CPIc CPIa TRADE REER}]$ . The VAR model is estimated in log levels using quarterly data over period (1994:1- 2005:4) to find the relationships between the real exchange rate, domestic and foreign inflation rates, and real-GDP, and trade-openness ratio in order to test the impact of the real exchange rate on the domestic and foreign inflation rates, and real-GDP, trade-openness ratio by using structural VAR approach using different tests (impulse response function and variance decomposition).

## 5.4 The Model and Variables

### 5.4.1 The Structural Vector Auto-regression (SVAR) Model

As a result of diverse fiscal and monetary policies, real exchange rates in some economies should follow a path that mirrors that effect of real shocks and in others they should follow a path that reflects monetary shocks.

A key issue in the SVAR approach is to decompose real exchange rate movements and gauge the relative importance of monetary and exchange rate policies. And it

could also examine the effects of shocks through impulse response function and variance decomposition and identify the causal influences on the real exchange rate. Underlying this approaches is the selection of appropriate variables that constitutes the Structural Vector Auto-regression (SVAR), moreover the structural approach imposes long-run restrictions from theory and allows identification of short-run influences. Therefore the Structural Vector Auto-regression (SVAR) model approach will be used to test this hypothesis, assuming long-run neutrality of nominal shocks; we decompose real exchange rate and price movements into those attributable to real and nominal shocks.

#### 5.4.2 Model variables

In all Structural VARs, each variable is expressed as a linear combination of lagged values of all other variables in the group. In practice, the Structural VAR equations may be expanded to include deterministic time trends, but the researcher uses quarterly data which appear to capture the effects of time trends.

In Structural VARs, as formulated by Sims (1980), all of the variables are assumed to be endogenous. Specifying some of the variables to be exogenous introduces restriction on the model, because such variables will be able to affect endogenous variable directly through feedback from the exogenous variables.

Through linearization, the nonlinear theoretical general equilibrium model can be transformed into a Structural Vector Auto-regression (SVAR) model that includes five variables: the exchange rate, domestic and foreign inflation rates, real-GDP, and trade-openness. As a result, instead of using nominal exchange rates, we thus

consider the log of the price level  $CPI_a$ ,  $CPI_c$ , measured by the Consumer Price Index (CPI), the log of real exchange rate REER, log of real-GDP and log of trade-openness ratio in our bivariate decompositions.

We take the GDP deflators of the China and US as indices of inflation indicators. Generally, the GDP deflator is a better index than the change of consumer prices, since it is a more comprehensive price indicator of various goods. Another reason for us to choose the GDP deflator as an index of inflation indicators is that other indicators, such as export and import price and consumer price of the China before 1994 are either unavailable or the time-series is too short for this study.

Based on the theoretical model, the following variables are used in the empirical model in China:

$CPI_c$ : per cent change of PRC deflator.

$CPI_a$ : per cent change of US deflator.

GDP: output level of the PRC versus US.

TRADE: trade balance of the PRC versus US.

REER: real effective exchange rate.

$Y_t = (GDP_t \text{ } CPI_c \text{ } CPI_a \text{ } TRADE_t \text{ } REER_t)$ : an endogenous variable vector.

And these endogenous variables (GDP,  $CPI_a$ ,  $CPI_c$ , TRADE, and REER) that will be used here are quarterly data during the period (1994:1-2005:4) in china.

## 5.5 Statistical Analyses

This section examines the time-series properties of the variables in the analysis. Many statistical techniques can be used to explain research data. The statistical technique used in this research to analyze the data is the time series analysis by using

the structural Vector Auto-regression (SVAR) approach.

The structural Vector Auto-regression (SVAR) is commonly used for forecasting system of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables (Eview User Guide's, 2004)

The empirical study includes five steps: (1) Selection of the lag length. (2) Unit root test of level variables, Unit root test of first order difference, and second order difference of level variables if necessary, (3) Cointegration test, (4) Impulse Response analysis, and (5) Variance Decomposition. The unit root test is used to test if a time series is non-stationary to determine if a regression is spurious. If the test confirms that a series has a unit root, the series is non-stationary. Non-stationary series of the same order of integration may have co-integrating relations. Thus, a cointegration test is needed. If cointegration relations exist, the next step is a structural VAR model estimation, which estimates both the long-run integration equations among endogenous variables and the short-run fluctuations. The purpose of impulse response analysis is then selecting a structural VAR to investigate how one variable responds to the impulse shock of another variable. In the case of the Renminbi, we want to understand what takes place once a one-time exchange rate adjustment is made under the pressure of the United States and other countries. The tests are examined by using the "Eviews" package (release 6.0).

#### 5.5.1 Model Selection Criteria (Selection of the lag Length)

Selection of the inappropriate lag length may cause a problem and may cause the residuals regression not to behave well. For a given data set, the selection criteria are

normally based on summary static from residuals computed from a fitted model.

According to Akaike Information Criteria (AIC), which is based on the residual variance, the appropriate lag length can be selected by choosing the minimum value of Akaike (residual variance) which will represent the suitable lag length. (Vogelvang, 2005, p.344) (Eviews user's guide, 2004, p.513).

The results shown in Table (5.1) are  $-32.21632$  (AIC) and  $-24.69332$  (SC), indicate a minimum lag length of 7. So the suitable lag length to be used here is (7) lag length.

Table 5.1

VAR Lag Order Selection Criteria

Endogenous variables: LNCPIA LNCPIK LNGDP LNREER LNTRADE

Exogenous variables: C

Date: 04/29/09 Time: 19:27

Sample: 1994Q1 2005Q4

Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	219.0041	NA	2.01e-11	-10.43922	-10.23025	-10.36313
1	450.0639	394.4924	8.77e-16	-20.49092	-19.23709	-20.03435
2	476.8113	39.14246	8.53e-16	-20.57616	-18.27746	-19.73910
3	523.0924	56.44045	3.51e-16	-21.61427	-18.27071	-20.39673
4	582.4334	57.89366	9.03e-17	-23.28944	-18.90102	-21.69142
5	618.4219	26.33304	9.69e-17	-23.82546	-18.39218	-21.84696
6	669.9414	25.13144	8.54e-17	-25.11909	-18.64095	-22.76011
7	840.4346	41.58370*	9.34e-19*	-32.21632*	-24.69332*	-29.47686*

\* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

### 5.5.2 Unit Root Testing

Knowing whether non-stationary in the data is due to a deterministic time trend or a

unit root would seem to be a very important question. Any time series data can be thought of as being generated by a stochastic or random process, and a concrete set of data can be regarded as a realization of the underlying stochastic process and its realization is a kin to the distinction between population and sample. Just as we use sample data to draw inferences about a population, in time series we use the realization to draw inferences about the underlying stochastic process.

A stochastic process is said to be stationary if its mean and variance are constant over time. According to Engle and Granger (1987), the direct application of OLS to non-stationary data produces regressions that are mis-specified or spurious in nature. These regressions tend to produce performance statistics that are inflated in nature, such as high  $R^2$ s and t-statistics, which often lead investigators to commit a high frequency of Type I errors (rejecting the true hypothesis) (Granger and Newbold, 1974). As is common, we therefore tested each of the variables in question for a unit root (non-stationary) using an Augmented Dickey-Fuller test (ADF) (Dickey and Fuller, 1981) based on estimation of the following equation:

$$\Delta Y_t = \alpha_0 + (\rho - 1)Y_{t-1} + \sum_{i=1}^p \theta \Delta Y_{t-i} + bT + \varepsilon_t \quad (5.2)$$

where  $Y_t$  is the variable under consideration,  $\Delta$  is the first-difference operator,  $\alpha_0$  is a constant and  $T$  is the time trend,  $p$  being the number of lags set to a maximum lag order of  $\sqrt{N}$  so  $N$  being the sample size. Failure to reject the null hypothesis of the unit root ( $\rho = 1$ ) signifies the presence of a non-stationary process. The null hypothesis of non-stationary (i.e. the given series is  $I(1)$ ) is not rejected if  $\rho$  is not



significantly different from unity.

A time series that has a unit root is known as a random walk. (Hamilton, 1994, pp.435-447). However, we need to have a stationary time series in our tests, otherwise, we'll have spurious regression.

To test the presence of a unit root, we will apply the Augmented Dickey-Fuller test. This test can also be used to help detect the presence of stochastic trend (Enders, 2004, p.156) (Cryer, 1986, pp.9-16)

If the computed ADF value exceeds the critical or tabulated value, then we fail to reject (accept) the null hypothesis that the variable has a unit root (non-stationary). However, if it is less than the critical value, then we reject the null hypothesis, so the variable will be stationary. (Eviews user's guide, 2004, pp.504-505) (Franses, 1998, pp.80-84)

Table 5.2 Unit Root Testing Results

Variable	Augmented Dickey-Fuller					
	1%	5%	10%	T-statistic	H0: Variable has a unit root	Is it stationary?
LnCPIa	-3.577	-2.925	-2.600	-0.389	Don't Reject	No
D(lnCPIa)	-3.584	-2.928	-2.602	-5.827	Reject	Yes
LnCPIc	-3.581	-2.926	-2.601	-2.431	Don't Reject	No
D(lnCPIc)	-3.581	-2.926	-2.601	-3.723	Reject	Yes
LnReer	-3.581	-2.926	-2.601	-2.258	Don't Reject	No
D(lnREER)	-3.581	-2.926	-2.601	-4.437	Reject	Yes
LnGDP	-3.605	-2.936	-2.606	-1.424	Don't Reject	No
D(lnGDP)	-3.605	-2.936	-2.606	-2.651	Reject	Yes
LnTRADE	-3.577	-2.925	-2.600	-2.320	Don't Reject	No
D(lnTRADE)	-3.581	-2.926	-2.601	-7.996	Reject	Yes

Formal stationarity tests are conducted and the results from the Augmented Dickey-Fuller unit root tests are reported in the Table 5.2. The null hypothesis of a

unit root cannot be rejected for the levels of all variables LNCPIa, LNCPIc, LNREER, LNTRADE and LNGDP, while the first difference is confirmed to be stationary for all of them.

### 5.5.3 Johansen Cointegration Test

Cointegration is an econometric property of time series variables. If two or more series are themselves non-stationary, but a linear combination of them is stationary, then the series are said to be co-integrated. It is often said that cointegration is a means for correctly testing hypotheses concerning the relationship between two variables having unit roots. The usual procedure for testing hypotheses concerning the relationship between non-stationary variables was to run Ordinary Least Squares (OLS) regressions on data which had initially been differenced. Although this method is correct in large samples, cointegration provides more powerful tools when the data sets are of limited length, as most economic time-series are.

The concept of cointegration was introduced in the econometric literature by Granger (1981) and further extended and formalized by Engle and Granger (1987). This concept is based on the idea that, although economic time series exhibit non-stationary behavior, an appropriate linear combination between trending variables could remove the common trend component. The resulting linear combination of the time series variables will thus be stationary, which means the relevant time series are co-integrated.

According to Engle and Granger (1987) a set of variables is said to be co-integrated or “to move together in the long-run” if a linear combination of their

individual integrated series  $I(d)$  is stationary where  $d$  is the order of integrated. From an economist's perspective, cointegration is of interest because of the possible existence of a long run or a steady state equilibrium relationship. The research on cointegration tests has developed in two main directions: (i) tests based on the residuals from a co-integrating regression suggested by Engle and Granger (1987); and (ii) tests based on the system of equations utilising vector autoregressive models, suggested by Johansen (1988, 1991) and Johansen and Juselius (1990).

The Engle-Granger (E-G) residual based test is one of the most commonly used cointegration tests. For models of co-integrated variables, this test involves the following two steps: (a) estimation of a co-integrating regression by applying OLS on the levels of the variables included; and (b) testing for stationarity of the residuals by using augmented Dickey-Fuller tests.

While the E-G single equation based cointegration tests have been used frequently in the literature, it has several limitations. First if there are more than two variables in the model, there can be more than one co-integrating combination. That is, the variables in a model may feature as part of several equilibrium relationships governing the joint evolution of the variables. Second, even if there is only one cointegration relationship, estimating a single equation is potentially inefficient because of the loss of information that results from inability of the model to treat all variables as potentially endogenous. Given that the number of cointegration vectors in a model is unknown, and given the need to allow all variables to be potential endogenous, the E-G single equation approach to testing for cointegration can give rise to misleading results.

The approach developed by Johansen (1988, 1991) and extended by Johansen and Juselius (1990) (explained briefly below) is considered superior to the E-G method, as it provides testing within a multivariate framework and allows for more than one cointegration vector in the estimated model thereby preventing loss of efficiency.

For the Johansen and Juselius method, two tests are commonly used to determine the number of co-integrating vectors. These are namely the trace test and the maximum-eigenvalue test statistics, stated as follows:

$$Trace = -T \sum_{i=r+1}^n \ln(1 - \lambda_i) \quad r = 0, 1, 2, \dots, n-2, n-1 \quad (5.3)$$

$$\lambda_{\max} = -T \ln(1 - \lambda_{r+1}) \quad r = 0, 1, 2, \dots, n-2, n-1 \quad (5.4)$$

where  $\lambda_i$  are the eigenvalues corresponding to the decomposition of the matrix of long run multipliers in the multivariate system<sup>22</sup>. In each case, the null hypothesis that there are at most  $r$  co-integrating combinations amounts to:

$$H_0: \lambda_i = 0 \quad i = r + 1, \dots, n$$

where only the first  $r$  eigenvalues are non-zero. Thus, the alternative for  $r = 0$  is that  $r = 1$ ;  $r = 1$  is tested against the alternative of  $r = 2$ ; and so on. If there is any divergence of results between these two tests, it is recommended that one should rely on the evidence based on the trace test, since the results of the latter test, as indicated by Banerjee et al. (1986, 1993), are more reliable.

In practice, cointegration is used for such series in typical econometric tests, but it is more generally applicable and can be used for variables integrated of higher order

<sup>22</sup> The derivation of the eigenvalues and the corresponding eigenvectors are not of interest here, see for example Harris (1995), Chapter 5 for more details. Chapter 6 briefly covers the representation of the multivariate system.

(to detect correlated accelerations or other second-difference effects).

Multi-cointegration extends the cointegration technique beyond two variables, and occasionally to variables integrated at different orders.

Next, we check whether the variables are co-integrated, although there is no economic reason to expect them to be co-integrated. However, if the variables were co-integrated, the structural VAR in first differences would be wrongly-specified, and the long-run relationship could be used to help obtain more efficient estimates of the short-run dynamics. Table 5.3 presents cointegration test results based on Johansen's maximum-likelihood procedure. Test results indicate that there are three cointegration relations among the four variables in consideration.

Table 5.3

Date: 05/06/09 Time: 17:01

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

Trend assumption: No deterministic trend (restricted constant)

Series: LNGDP LNCPIC LNCPIA LNTRADE LNREER

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.692293	149.9597	76.97277	0.0000
At most 1 *	0.621383	95.74384	54.07904	0.0000
At most 2 *	0.436209	51.06722	35.19275	0.0005
At most 3 *	0.321225	24.70595	20.26184	0.0114
At most 4	0.138965	6.882545	9.164546	0.1327

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

## Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.692293	54.21588	34.80587	0.0001
At most 1 *	0.621383	44.67662	28.58808	0.0002
At most 2 *	0.436209	26.36126	22.29962	0.0128
At most 3 *	0.321225	17.82341	15.89210	0.0246
At most 4	0.138965	6.882545	9.164546	0.1327

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

## 5.6 Results from the structural VAR Model

By estimating a structural VAR model containing five variables; Real exchange rate relative to the US dollar (its main trading partner) ( $R_t$ ), real GDP relative to the US ( $Y_t$ ), consumer prices level of China ( $P_{ct}$ ), consumer price level of US ( $P_{at}$ ) and trade-openness ( $Trade_t$ ), four structural shocks can be identified; real demand shocks ( $\epsilon_t^{RD}$ ), nominal shocks ( $\epsilon_t^{NOMc}$ ), ( $\epsilon_t^{NOMa}$ ), aggregate supply shocks ( $\epsilon_t^{AS}$ ) and trade-openness shocks ( $\epsilon_t^{TP}$ ).

Assume for now that all variables are non-stationary integrated,  $I(1)$ , variables, where stationary is obtained by taking first differences. Ordering the vector of stationary variables as  $Z_t = (\Delta T_t, \Delta Y_t, \Delta R_t, \Delta P_{ct}, \Delta P_{at})$ , its moving average representation can be written as:

$$z_t = C(L) e_t \quad (5.5)$$

where  $e_t$  is a vector of reduced form serially uncorrelated residuals with covariance

matrix  $\Omega$ . Assume that the orthogonal structural disturbances ( $\varepsilon_t$ ) can be written as linear combinations of the innovations ( $e_t$ ), i.e.  $e_t = D_0 \varepsilon_t$ . A (restricted) form of the moving average containing the vector of original disturbances can then be found as:

$$z_t = D(L) \varepsilon_t \quad (5.6)$$

where  $C(L)D_0 = D(L)$ . The  $\varepsilon_t$ 's are normalized so they all have unit variance. If  $D_0$  is identified, one can derive the MA representation in (5.6). However, the  $D_0$  matrix contains twenty elements, so to orthogonalize the different innovations, twenty restrictions are needed. First, from the normalization of  $\text{var}(\varepsilon_t)$  it follows that

$$\Omega = D_0 D_0'.$$

A four variable system imposes ten restrictions on the elements in  $D_0$ . Ten more restrictions are then needed to identify  $D_0$ . These will come from restrictions on the long run multipliers of the  $D(L)$  matrix. Ordering the four serially uncorrelated orthogonal structural shocks:

$$\varepsilon_t = (\varepsilon_t^{\text{Trade}}, \varepsilon_t^{\text{AS}}, \varepsilon_t^{\text{RD}}, \varepsilon_t^{\text{NOMc}}, \varepsilon_t^{\text{NOMa}})',$$

the long run expression of (5.6) can then simply be written as:

$$\begin{bmatrix} \Delta T \\ \Delta Y \\ \Delta S \\ \Delta P_C \\ \Delta P_A \end{bmatrix} = \begin{bmatrix} D_{11}(l) & D_{12}(l) & D_{13}(l) & D_{14}(l) & D_{15}(l) \\ D_{21}(l) & D_{22}(l) & D_{23}(l) & D_{24}(l) & D_{25}(l) \\ D_{31}(l) & D_{32}(l) & D_{33}(l) & D_{34}(l) & D_{35}(l) \\ D_{41}(l) & D_{42}(l) & D_{43}(l) & D_{44}(l) & D_{45}(l) \\ D_{51}(l) & D_{52}(l) & D_{53}(l) & D_{54}(l) & D_{55}(l) \end{bmatrix} \begin{bmatrix} \varepsilon^{\text{Trade}} \\ \varepsilon^{\text{AS}} \\ \varepsilon^{\text{AD}} \\ \varepsilon^{\text{Nom}_C} \\ \varepsilon^{\text{Nom}_A} \end{bmatrix} \quad (5.7)$$

where  $D(1) = \sum_{j=0}^{\infty} D_j$  indicate the long run matrix of  $D(L)$ . The restrictions on the

long-run multipliers of the system that are used here to identify the structural shocks

are based on a standard open economy model, as that presented in Bjørnland (2000).

First, all shocks but the nominal shock can potentially have a long run effect on the real exchange rate. The restriction that the nominal shock can have only short term effects on the real exchange rate is consistent with most models of short run exchange rate variability, but long run PPP (cf. Clarida and Gali 1994). Thus:

$$D_{34}(1) = D_{35}(1) = D_{45}(1) = 0 \quad (5.8)$$

Second, the key (long run) identifying assumption that distinguishes between the demand and supply shocks, asserts that in the long run, the level of production will be determined by supply side factors (aggregate supply and real oil price shocks) only (cf. Blanchard and Quah 1989). However, in the short run, due to nominal and real rigidities, all four disturbances can influence production. Hence:

$$D_{23}(1) = D_{24}(1) = D_{25}(1) = 0 \quad (5.9)$$

Finally, the trade-openness shock itself is identified as the only shock that can have a long run effect on the real trade. However, in the short run, all shocks are allowed to influence trade-openness:

$$D_{12}(1) = D_{13}(1) = D_{14}(1) = D_{15}(1) = 0 \quad (5.10)$$

No restrictions are placed on prices, although there are some over identifying restrictions on prices that can be tested informally by examining the impulse response analysis. For instance, the standard aggregate demand/supply diagram suggests that whereas positive real demand and nominal shocks (that increase production only temporarily) shall increase prices permanently, following a positive aggregate supply shock (that increases production permanently), prices shall fall permanently.



With the ten long run restrictions, the matrix  $D(1)$  will be lower triangular, and one can use this to recover  $D_0$ . The long run representation of expression (5.6) implies:

$$C(1)\Omega C(1)'=D(1)D(1)' \quad (5.11)$$

(5.11) can be computed from the estimate of  $\Omega$  and  $C(1)$ . As  $D(1)$  is lower triangular, expression (5.11) implies that  $D(1)$  will be the unique lower triangular Choleski factor of  $C(1)\Omega C(1)'$ .

### 5.6.1 Impulse Response Analysis

While the sample period may be too short to assess mean reversion in real exchange rates, we believe that it is appropriate to model exchange rates as a SVAR process for impulse response analysis. This assumption allows us to estimate the exchange rate variability attributable to nominal and to real shocks, subject to long run restriction. Assuming non-stationary real exchange rates is reasonably appropriate for two reasons. First, purchasing power parity, which implies stationary real exchange rates, holds under very restrictive conditions that are unlikely to be met in transition economies (Brada, 1998). Second, in their analysis of equilibrium real exchange rates in transition economies, Halpern and Wyplosz (1997) argue that equilibrium real exchange rates should exhibit an upward trend over time as these countries catch up with the West and as productivity and real wages increase over time.

Because such shocks are generally random or stochastic in nature, real exchange rates will have a permanent or stochastic component during this period. Consider two

types of orthogonal shocks, each of which could be the source of variation in the observed movements in real exchange rates and prices. A real shock,  $\varepsilon_{rt}$ , reflects changes in endowment, productivity shocks, and technology, and a nominal shock,  $\varepsilon_{nt}$ , is caused by nominal money supply shocks or devaluation of the exchange rate. For simplicity let the vector  $\Delta y_t = [\Delta q_t \ \Delta p_t]'$  is stationary, it can be written as an infinite moving average in the structural shocks; i.e.,

$$\begin{bmatrix} \Delta q_t \\ \Delta p_t \end{bmatrix} = \begin{bmatrix} A_{11}(L)A_{12}(L) \\ A_{21}(L)A_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{rt} \\ \varepsilon_{nt} \end{bmatrix} \quad (5.12)$$

where  $A_{ij}$  are polynomials in the lag operator,  $L$ . In order to identify the shocks, it is assumed that nominal shocks have no long-run effect on the real exchange rate. This assumption can be imposed by restricting the coefficients in  $A_{12}(L)$  to sum to zero. If  $a_{ij}(k)$  is the  $k$ th coefficient in  $A_{ij}(L)$ , the restriction is equivalent to

$$\sum_{k=0}^{\infty} a_{12}(k) = 0 \quad (5.13)$$

so that the cumulative effect of  $\varepsilon_{nt}$  on  $\Delta q_t$  is zero. Note that the effects of nominal and real shocks on prices are not restricted. This method of decomposing a series into its permanent and temporary components is valid provided the joint behavior of real exchange rate and price level contains reliable information about the underlying sources of fluctuations (Lastrapes, 1992).

The impulse response function (IRF) traces out the response of one variable in the structural VAR system to shocks in the error terms.

A shock in the (i-th) variable not only directly affects the (i-th) variable but is also

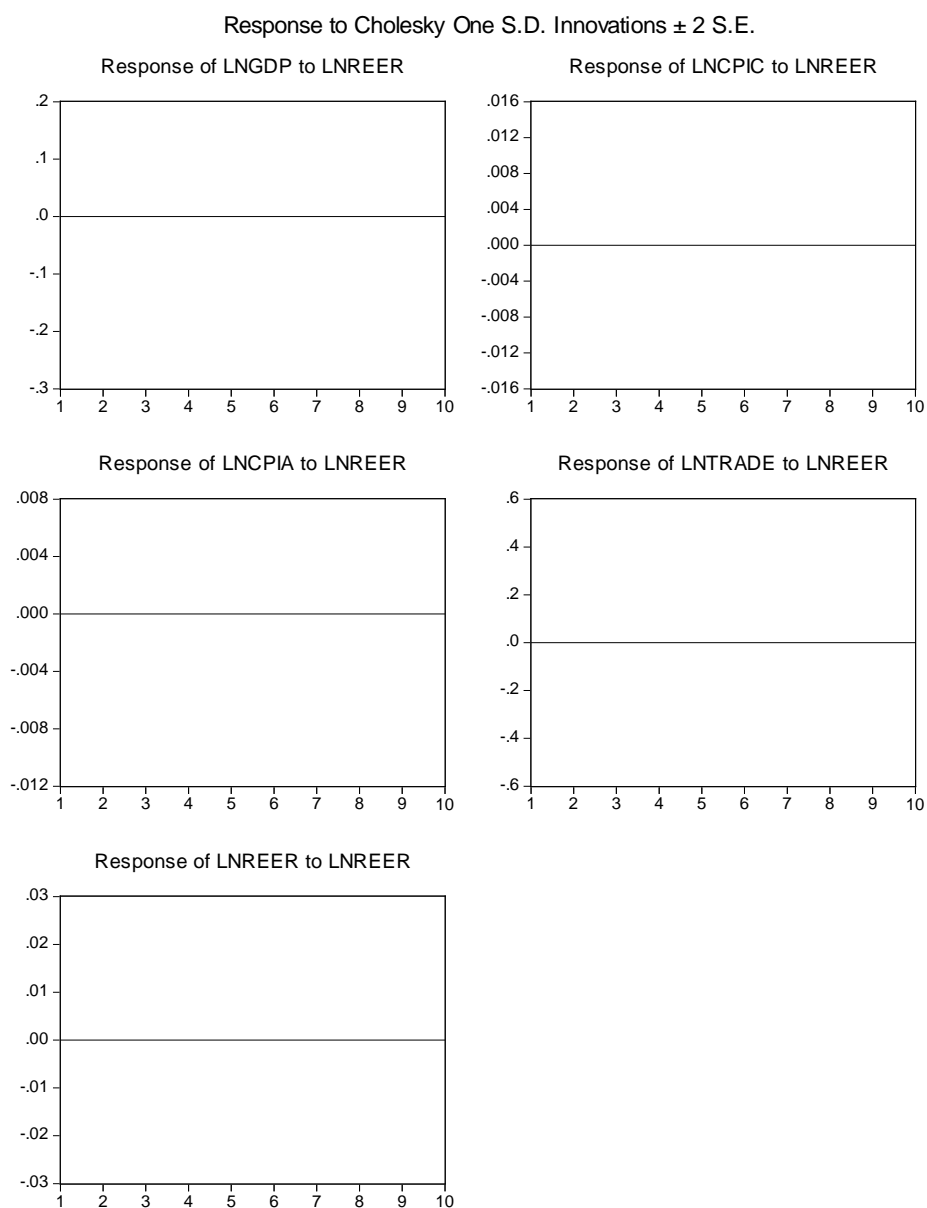
transmitted to all of the other endogenous variables through the dynamic (lag) structure of the lag.

However, it is important to clarify the usefulness of the impulse response methodology, as it might be a key magnitude for describing the effects of the monetary policy on the economy in general, and the effects on capital markets in this research. Its usefulness comes from testing the unanticipated and anticipated changes in monetary policy. It can reveal the effect of a monetary shock if it followed by usual policy actions. However, if only unanticipated money matter, the impulse response function reveals the structural coefficients of the model. Moreover, the impulse response function is enduring to changes in monetary regimes. And that's because none of the broadcast of a monetary shock for example output, operates through the subsequent effect on anticipated money. Another case can be if the policy changes so that money changes become more persistent, the response of output will be different. Therefore, impulse response function from the Structural VAR is the natural method for analyzing such effects.

All variables are co-integrated with four cointegration relationship therefore structural VAR model is used for Impulse Response Function and Variance Decomposition analysis. Regarding the impulse response function, which is used to estimate the dynamic response of each variable to an unexpected change in another variable, is a practical way to visually represent the behaviour of the variable series in response to the various shocks and see what the relationship between the variables is whether the shock was increasing or decreasing. Figure 5.1 shows the impulse

response function of a shock in the real exchange rate, in order to establish to nature of fluctuations between the variables. The figure shows the impulse response with upper and lowers two standard error bands for the Structural VAR model of this study.

Figure 5.1 Impulse Response Function of a Shock in the Real Exchange Rate.(*The Structural VAR formulated as  $-real-GDP$  (shock1),  $Chinese-CPI$  (shock2),  $US-CPI$  (shock3),  $trade-openness$  (shock4) and  $REER$  (shock 5)*)



The first row in the figure shows the dynamic response of the GDP shock in the

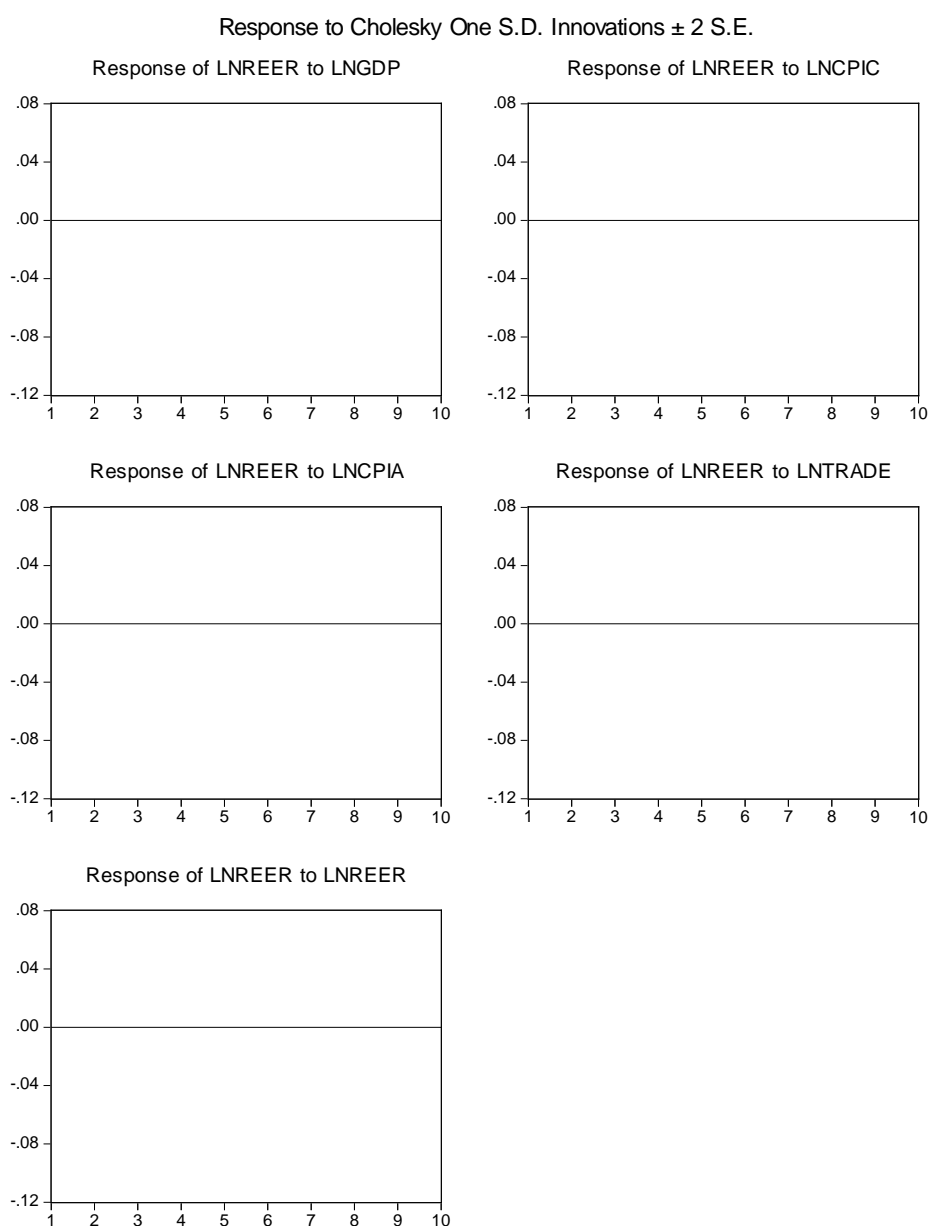
real exchange, and the response of the dynamic response of the inflation rate of China ratio to shock in the real exchange rate. The figure shows that there's a significant positive and negative effect from the real exchange rate to real-GDP. It is clear that any shock in the real exchange rate has a positive effect on real-GDP, where persists for the month three to month five, then turns to negative for another two months until month seven, then increase to positive for another three months, until month nine it drops again to negative until the end of the period. The dynamic response of the inflation rate of China to shock in the real exchange rate is similar as it has both a significant positive and negative effect during the period, specially the negative effect during month four to month nine, after that the effect of the shock increase further to positive until the end of the period.

The second row in the figure shows the dynamic response of the inflation rate of US to shock in the real exchange rate and the trade-openness to shock in the real exchange rate. As for the response of inflation rate of US to real exchange rate, the figure shows that the impact will be insignificant but negative for most of the period. Finally the shock of trade-openness's response to real exchange rate change was positive and negative effect under most of the periods, particular at month six and nine. However it increases to positive just before the ending period of month eight.

Figure 5.2 displays the impulse response functions of the real exchange rate to shock in the log level of real-GDP, inflation rate of China, inflation rate of US, and trade openness ratio to one standard deviation structural shocks. Since the variables

were entered in first difference in VAR, the resulting impulse responses were cumulated in order to obtain the impulse response reported in Figure 5.2. These impulse response functions are in line with the theoretical priors discussed above.

Figure 5.2 Impulse Response Function of a response of the Real Exchange Rate to shocks in other variables. (*The Structural VAR formulated as  $-real-GDP(shock1)$ ,  $Chinese-CPI(shock2)$ ,  $US-CPI(shock3)$ ,  $trade-openness(shock4)$  and  $REER(shock5)$* )



The first row in the figure shows that dynamic response of the real exchange rate to shock in the real-GDP. The shock response of real exchange rate to the real-GDP is negative during the long run; especially the negative shock appears in month seven to month nine. Also the dynamic response of real exchange rate shock to the inflation rate of China was showing that similar situation, showing the negative effect until the end of the period.

The second row in the Figure 5.2 shows that dynamic response of real exchange rate shock to the inflation rate of US, and dynamic response of real exchange rate shock to trade-openness. US inflation is response to the Chinese exchange rate shock remain positive and continually increases during the estimate period. In contract, a negative shock response of real exchange rate to the trade-openness during the most of the period, until the end of the period.

### 5.6.2 Variance Decomposition

While impulse responses are useful in assessing the signs and magnitudes of responses to specific shocks, the relative importance of different shocks for a particular variable's fluctuations can really be gauged properly through the forecast error variance decompositions. This is a way of characterizing the dynamic behaviour of the model, by breaking down the variance of the forecast error for each variable into components that can be attributed to each of the endogenous variables.

The variance decomposition of a structural VAR gives information about the relative importance of random innovations. And if  $e_{xt}$  shocks explain none of the

forecast error variance of  $(Y_t)$  at all forecast horizon, we can say that the  $(Y_t)$  sequence is exogenous. On the other hand, if  $e_{zt}$  shocks could explain all of the forecast error in the  $(Y_t)$  sequence at all forecast horizon,  $(Y_t)$  would be entirely endogenous. In practice, it is typical for a variable to explain most of the forecast error variance at short horizons and some at larger horizons. We would expect this pattern if a variable had little effect on the other variable (Enders, 2004, Box, Jenkins and Reinsel, 1994).

Hence, impulse response function and variance decomposition (together called innovation accounting) can be useful tools to examine the relationships among economic variables. If the correlation among the various innovations is small, the identification problem is not likely to be especially important (Enders, 2004, p.280) (Chatfield, 1996).

Using the estimated structural VAR, a historical decomposition can be derived to examine whether or not the supply, and demand shocks that have been identified can plausibly explain the time path followed by the Renminbi real exchange rate over the last ten years. For example, we can verify whether episodes of tight money or positive real demand shocks are associated with real appreciation of the Renminbi. Table 5.4 shows the unconditional forecast error for the real exchange rate and shows the decomposition of this forecast error into the components that can be attributed to real/supply, and nominal/demand shocks.



Table 5.4: Variance Decomposition of D (LNREER)

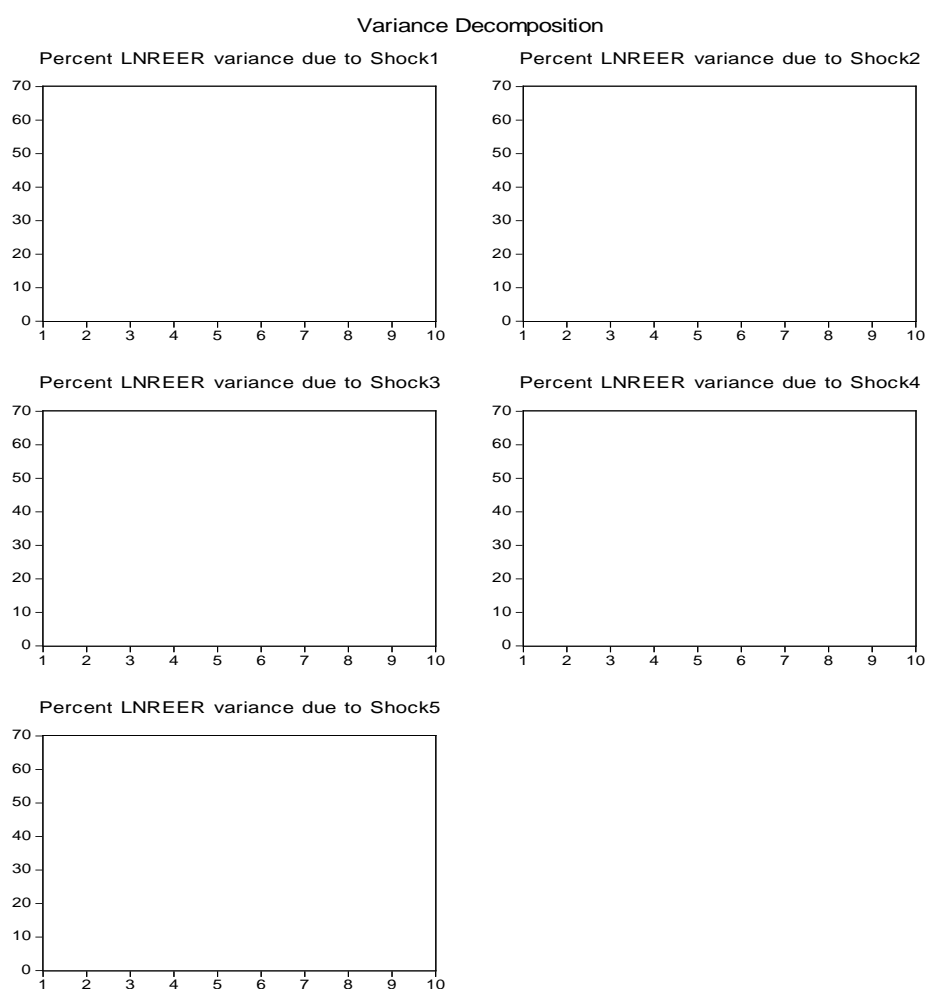
*The Structural VAR formulated as –real-GDP(shock1), chinese-CPI(shock2), US-CPI(shock3), trade-openness(shock4) and REER(shock 5)*

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5
1	0.044168	7.829051	13.60596	59.22653	0.264801	19.07365
2	0.053884	2.067767	57.34615	16.06630	14.66758	9.852197
3	0.069178	11.81354	48.09407	10.81079	22.25528	7.026318
4	0.100986	5.375280	58.88099	4.615820	25.21213	5.915784
5	0.180034	18.29863	53.89847	1.544248	21.99486	4.263799
6	0.197930	34.94495	43.58822	1.151045	16.80693	3.508859
7	0.266406	20.63565	41.57730	1.843109	28.70759	7.236352
8	0.467847	25.30108	44.07117	1.702317	23.11504	5.810389
9	0.570306	6.294846	64.34569	0.821716	23.13805	5.399698
10	0.911663	20.31885	50.17699	0.583452	24.09973	4.820979

Table 5.4 reports variance Decomposition at 10 period's horizon for the Structural VAR ahead of the variables. The results indicate that the inflation rate of China has very significant effect on the REER. The variance of decomposition of the forecast error of the real exchange rate is explained by real GDP doesn't have much impact at beginning few months, but slight increase and decrease every few months, and remain about 20% until the end of the period. The most important factors explaining the REER are the inflation rate of China, which could explain more than 50% of the total period. Compared with the inflation rate of US, the variance decomposition of the forecast error of the real exchange rate is explained by inflation rate of US of approximately 59% in beginning, with the percentage slight decrease to 16 in month two, after that it continues to decrease to 0 until the end of the period. Unfortunately, the results from Table 5.4 indicate that the real exchange rate doesn't have much impact on the inflation rate of US in long run. However, the results

indicate that the real exchange rate shock has a significant impact on the trade-openness. The variance decomposition of the forecast error of the real exchange rate is explained by inflation rate of China of approximately 0.26% in beginning, with percentage increase to 22.25% in month four, after that it continues to rise and remains around 24% until the end of the period.

Figure 5.3 Variance Decomposition



As an explanation from the variance decomposition, relative nominal demand shocks account for most of the fluctuation in the real exchange rate changes during the estimation period, as shown in the Figure 5.3, and account for about more than

half of the variance in exchange rate movement even in the long run. The overall importance of nominal shocks to the variations of real exchange rate changes is consistent with findings on other developing countries (e.g., Chen and Wu, 1997; Ahmed, 2003). Supply shocks also have a significant contribution over longer horizons. Compared with studies on industrial countries with flexible exchange rate systems (Eichenbaum and Evans, 1993; Clarida and Gali, 1994), supply shocks here play a significant but little less important role, maybe because china has been going through only minor supply side changes such as structural reforms and productivity shocks. Moreover, nominal shocks from US appear not to have played as large a role as from China in the long period, only significant in the beginning few months then continue to decrease sharply further until the end of the period, it was explaining the fluctuations in either output growth or real exchange rate movement, possibly because China has a de facto fixed exchange rate system with relatively closed capital account. The dominance of supply shocks in the fluctuations of output growth found here is consistent with the findings of Ahmed (2003) for Latin American economies, and Hoffmaister and Roldos (2001) for Korea. Hoffmaister and Roldos (2001) also find that nominal shocks contribute more than supply shocks to the fluctuations of changes in the real exchange rate in the case of Korea.

## 5.7 Further Analysis: Indicators of Real Exchange Rate Movement

Using the estimated Structural VAR, a historical decomposition can be derived to examine whether or not the real and nominal shocks that have been identified can

plausibly explain the time path followed by the Renminbi real exchange rate over the last two decades. For example, we can verify whether episodes of positive real shocks are associated with real appreciation of the Renminbi.

The solid line in Figure 5.4 plot the actual (log level of the) real exchange rate, the data obtained from IFS during the period from 1994 to 2005. And the dashed line in the panels is the total forecast error; the dashed line reflects the cumulative impact of the three types of structural shocks between 1994 and 2005. In other words, the

Figure 5.4 Overvaluation or Undervaluation for China Exchange Rate during 1994-2005

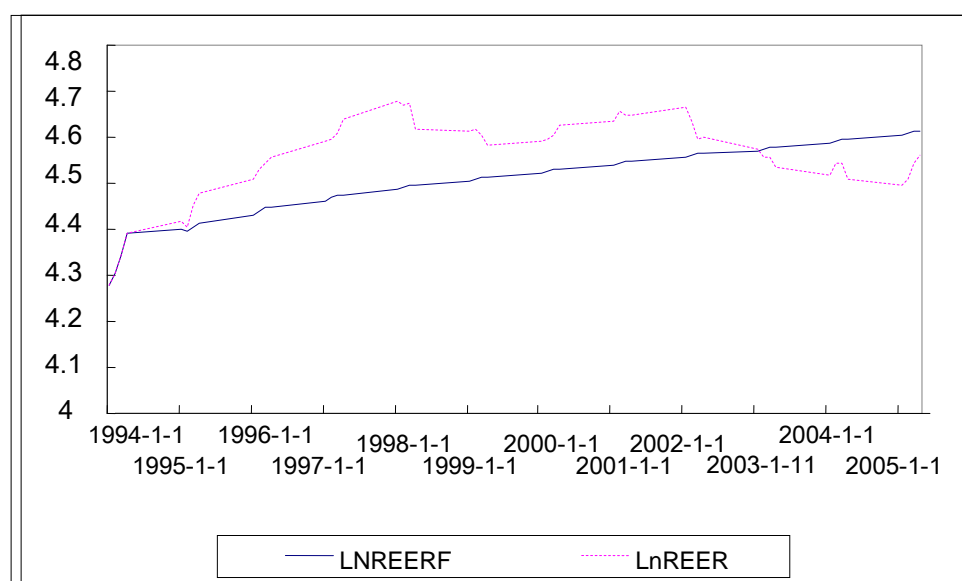


Figure 5.4 depicts the difference between the actual (log level of the) real exchange rate and the level that would have been forecast from the Structural VAR based on the history of the system up through 1994. Therefore, from the Figure 5.4 it is clear to see that during period 2000 to 2002, the RMB was overvalued, the highest overvaluation was about 10% in January 2002, and then it declined drastically within only few

months. From 2003, the RMB was undervalued gradually and continued until end of the research period. In year 2005, the RMB was undervalued around 11% compare with the result we get from the model. This was led by fiscal expansion and rapid investment growth in July 2005, the central bank of China implemented new policies on RMB exchange rate reform. Both these factors contributed to the appreciation of the real exchange rate. From the analysis, it could be argued that the RMB will continue to appreciate to catch the right level.

## 5.8 Summary

This chapter has focused on the research methodology employed for empirical analysis. The quantitative approach represented by the econometrics analysis of Chinese macroeconomic data has been used. In addition, this chapter also discussed the statistical techniques for testing the hypotheses. These statistical techniques included: selection the lag length, unit root test, johansen cointegration test, impulse response function and variance decomposition.

This chapter has also discussed the results of impulse response function and variance decomposition, conducting within a structural VAR framework, and also examined the research hypotheses regarding the relationship among the real exchange rate represented by a number of macroeconomic variables for China.

After specifying properly the structural VAR, the restriction in Eq. (5.7) is imposed and the shocks are identified. The dynamic effects of the nominal and real shocks can be analyzed by impulse response functions (IRF) and variance decompositions (VDC).

It is proved that the responses of the real exchange rate to nominal shocks in the case of China are consistent with the standard theoretical prior of a fixed exchange rate system. Under a fixed exchange rate, since the nominal exchange rate is (at least initially) fixed, as the price level goes up in response to a positive nominal shock, the real exchange rate would appreciate. Subsequently, capital outflows due to lower domestic interest rates and/or worsening of the external current account caused by the initial real appreciation could then lead to a devaluation of the nominal exchange rate and a depreciation of the real rate. Under a flexible exchange rate arrangement, a positive nominal shock is expected to lower domestic interest rates relative to foreign rate, leading to a capital outflow and a depreciation of both nominal and real exchange rate while the price level and output rise in the short run. The estimation result here shows that, China has been under a fixed exchange rate arrangement for much of the estimation period, the real exchange rate appreciates immediately in response to a positive nominal shock. With quarterly data, the initial appreciation impact of a positive nominal shock on the real exchange rate is identified. Moreover, the contribution of nominal shocks to the variation in changes of the real exchange rate is quite significant compared with contribution of nominal shock coming from US.

As an explanation from the variance decomposition, relative nominal demand shocks account for most of the fluctuation in the real exchange rate changes during the estimation period, as shown in the Figure 5.1, especially in the short run, and account for about more than half of the variance in exchange rate movement even in

the long run. The overall importance of nominal shocks to the variations of real exchange rate changes is consistent with findings on other developing countries (e.g., Chen and Wu, 1997; Ahmed, 2003). Supply shocks also have a significant contribution that rises over longer horizons. Compared with studies on industrial countries with flexible exchange rate systems (Eichenbaum and Evans, 1993; Clarida and Gali, 1994), supply shock here play a significant but little less important role, maybe because china has been going through only minor supply side changes such as structural reforms and productivity shocks. Moreover, nominal shocks from China appear to have played as large important role compared with US in explaining the fluctuations in either output growth or real exchange rate movement, possibly because China has a de facto fixed exchange rate system with relatively closed capital account. The dominance of nominal shocks in the fluctuations of output growth found here is consistent with the findings of Ahmed (2003) for Latin American economies, and Hoffmaister and Roldos (2001) for Korea. Hoffmaister and Roldos (2001) also find that nominal shocks contribute more than supply shocks to the fluctuations of changes in the real exchange rate in the case of Korea.

To sum up, based on the empirical results of this study, the real exchange rate in the economy to domestic output, domestic price shock and external shock in the past appears not to have played the equilibrating role that we might expect it to play based on economic theory. However, these results as representative of the responses of China economies to various shocks, the results are mixed, and making a clear case against or in favour of rigidly fixed exchange rates is difficult. Since the shocks

appear to cause fluctuations in the real exchange rate, the case for more independent use of monetary policy supported by a flexible but gradual approach is appropriate.



## **Chapter 6 Conclusion and Discussion**

### **6.1 Introduction**

Ever since China's economic reform in 1978, China's exchange rate regime kept evolving along with its reform, in order to pave the way for its rapid economic growth over ten years. The reform can be seen as a gradual process. While doing so, China's exchange rate regime has to accompany this liberalization in order to keep pace with its economic growth. Starting with the evolution of China's exchange rate regime, this study surveyed the literature on China's exchange policy, and analysed the current regime theoretically and empirically. This final chapter discusses the main findings and evaluates the case for greater exchange rate flexibility.

### **6.2 Evolution of China's exchange rate regime**

Before 1979 the relatively tiny amount of foreign trade meant the exchange rate of RMB had an insignificant effect on the planned economy. This monopolistic structure helped china insulate against foreign economic shocks. The authorities could manipulate foreign trade plans in accordance with the target of central planned economy in which exports generate enough foreign exchange to support imports, while imports were expected to fill the gap made up the differenced between domestic demand and supply. This foreign exchange system was inefficient, since central planning could deprive firms' autonomy which leads to low incentive and moral hazard. The pre-reform exchange rate was not a functional tool for the foreign trade to regulate the market demand and supply. In 1979 Chinese authorities began the

economic reforms. Foreign exchange allocation mechanism transformed, from one controlled by government to the one more or less determined by market. Authorities set up foreign currency control department and allowed export sector to retain a fraction of foreign earning aiming to introduce incentives among exporters. In 1981 authorities introduced RMB Internal Settlement Rate for export sector, while still retaining the overvalued exchange rate in non-trade transaction. The introduction of ISR was the first attempt for authorities to adjust the RMB exchange rate according to the structure of domestic prices since 1949. Although the ISR was not adjusted by following market supply and demand force, the ISR more or less alleviated the extent of the RMB overvaluation and to the appreciated official exchange rate. The overvalued RMB became a heavy burden for the authorities as they wanted to further open up the domestic market. To offset the adverse effect of export subsidies and distortion effects of the overvalued official exchange rate, from the mid 80s to early 90s the foreign exchange swap market played a significant role in China's foreign exchange system. To motivate the capital inflow, government allowed the foreign firms to swap foreign exchange among which the buyers and sellers negotiated the swap price. Aiming to get access to the WTO, in 1994 China deepened the economy is reform on foreign exchange, foreign trade and investment. As for foreign exchange reform, the RMB official and swap rates were unified at the rate of 8.7 Yuan per dollar at the end of 1993. The foreign exchange control on imports was also abolished.

After the exchange rate unification, the trade balance turned from deficit in 1993 into a surplus in 1994 and FDI also increased in 1994. This led to appreciation of

RMB; in turn by the end of 1996 RMB was around 8.28 Yuan per US dollar. In 1996, the government mainly focused on the full convertibility of current account. The government relaxed the control on private foreign exchange transactions and China's average tariff level was brought down from 35.9 percent to 23 percent. The capital account on the other hand was still in tight control because of the lesson from Asian Crisis. During Asian Crisis, China's authorities announced a stability of RMB exchange rate. The RMB exchange rate fluctuated in the range of 0.1 percent. In addition, depreciations in its neighbouring countries imposed strong deflationary pressure on China, the consumer prices grew at a negative rate in early 1998. However, China's defend of its peg during the Asian Crises helped avoid the collapse of currency values among Asian countries and stabilized the regional economy growth. The experience of the Asian Crisis has shown how vulnerable a country is to a financial crisis if it has fixed exchange rate and liberalized capital market, especially when country has large short-term dollar indebtedness.

After its accession to the WTO in 2001, China was finally accepted. China has liberalized its trade and investment policy, whereas capital account is still in tight control, reflecting the authorities' concern about illegal capital flight, macroeconomic instability, and undeveloped domestic financial sector. However, to further liberalize the foreign exchange regime, China has to free the capital account in future. In this respect, China needs to have sound financial system, prudent fiscal and monetary policy, equilibrium exchange rate, and an adequate level of foreign reserves. The reform of financial sector is a crucial task for the Chinese authority in turning it into a

sound system. Especially since the WTO accession has led to a direct competition between foreign and domestic financial institutions, the reform seems formidable task. After the Asian Crisis, China's economic growth is back on fast track, the net export and foreign direct investment grew synchronously, which led the official foreign reserve to accumulate quickly. In 2005, China modified its exchange rate arrangement from a single peg against US dollar to a basket peg regime. This can be seen as a further step for the authorities to move towards a floating exchange rate, and in doing so China is now preparing to open its capital account.

### 6.3 Literature review on China's exchange regime

The 1997 Asian Crisis generated a wide debate between fixed and floating exchange rate among scholars. Some Economists attribute the cause of crisis to the combination of fixed exchange rate and dollar indebtedness. However, empirical studies show that after Asian Crisis the fluctuation of East Asian countries' exchange rates is not the sign of flexible exchange rate; rather the over depreciation during crisis leads to appreciation, there is trend for exchange rates to be pegged against dollar. Also their foreign exchange reserves accumulation has been far above their pre-crisis levels. There are several reasons to adopt fixed exchange rate. Firstly, the nominal anchor argument for monetary policy is of most interest by economists. This argument is derived from the time inconsistency problem of monetary policy conduct in a closed economy. In an open economy, a nominal anchor can 'import' monetary discipline and low inflation by requiring that the central bank follow the monetary

policy of another country. Therefore, with nominal anchor, individuals would expect low inflation in the future because the currency peg will prevent the central planners from expanding money supply even if they wanted to. Thus country with nominal anchor can attain a lower level of inflation for any given level of output. The nominal anchor argument, however, works only through individual's expectation on inflation, and the credibility of authorities' announcement. Many economists argue that many central banks in emerging market have accountability problem. If central banks lack credibility, then fixed exchange rate may be worse than floating exchange rate, since floating exchange rate can at least play a key indicator of the stance of monetary policy. In the case of China's exchange rate, the revaluation in July 2005 implies that the credibility of this fixed exchange rate regime is not reliable. Another reason of fixed exchange rate adoption is derived from game theory; the outcome of fixed exchange rate is the result of Nash Equilibrium. International trade normally constitutes major part of GDP in emerging market. Therefore, fixed exchange rate can prevent competitive depreciation. Third reason for exchange rate to be fixed is that high exchange rate variability would create uncertainty, which would discourage international trade and investment. By fixing the exchange rate to its major trade partner can then eliminate exchange rate risk and transaction costs, and thus encourage investment and international trade. Although this argument seems debatable from empirical point of view, yet since emerging markets have less developed forward and future market, the fixed exchange rate is a good tool to ensure the stability of their currencies. The last reason for fixed exchange rate is "Original

Sin". The empirical studies on emerging markets shows that all domestic investments have either a maturity mismatch- long term investments financed by short term loans, and currency mismatch- investments using domestic currency financed by foreign currency. In order to offset the non-existent future or forward exchange in emerging markets, the government is induced to provide an informal hedge when borrowing abroad by keeping the exchange rate fixed to major currencies.

In July 2005 Chinese official announced a new exchange rate policy of targeting a basket of currencies. But until late 2006 the de facto regime began to put a significant weight on some non-dollar currencies. There is a large scale of articles on the evaluation of China's exchange policy from various perspectives. The economists could not reach consensus on two points: the degree of the undervaluation of RMB and the time and steps to adjust the current exchange regime of China. However, majority of empirical studies show that the RMB is undervalued in between 5 to 30 percent. Although the strand of economists who had undertaken the technical calculation of the 'equilibrium' value of the RMB declared that there were clear evidence showing the RMB was undervalued, most of them did not agree that a swift revaluation would resolve the underlying problems facing China once for all. However, there is a certain consensus among the economists, that is as long as China's capital market is free the adoption of floating exchange rate is inevitable, in other words, it is just matter of time for China's exchange policy to end up with floating exchange rate.

## 6.4 Concluding theoretical model

The theoretical model we have seen in Chapter 4 analyses the effect of nominal and real variables on financial exchange rate. The basic idea is that the system of dual exchange rates and the system of hard peg with capital control are juxtaposed together for comparisons and analyses. The standard argument for a dual exchange rate regime assumes that the exchange rate for transactions of goods and capital are segregated and channelled into two categories of markets: one for current account transactions and the other for capital account transactions. In such a system, a majority of imports and export transactions assigned with higher priority by the government are settled in the official foreign exchange market; a tiny proportion of other current account transactions with lower priority and all the capital transactions are settled in the financial exchange market. A prototype of the dual exchange rate system is usually assumed with a pegged official exchange rate, or in other words the commercial rate, and a freely adjusted financial exchange rate. The government holds foreign reserves to maintain the official exchange rate but the financial rate is mainly determined by market force.

The results deduced from the model were in line with the traditional theories and conclusions. For example, the effects of domestic credit expansion based on this model are no much different from the one we obtain from Krugman's model of first generation speculative attack. As a result, in the long-run, the net effect of a permanent domestic credit expansion is that the financial exchange rate initially overshoots and then comes back to its original level in the long run, and the final

equilibrium level of foreign reserve decreases. Domestic output expansion affects not only the long run foreign reserves, but also in the long run financial exchange rate. The increase in output leads to the expansion of foreign reserves. Therefore, in a dual exchange rate regime, the foreign reserve will move in the same direction as the change in output. But the new equilibrium financial exchange rate will depend on the particular structural parameters. By virtue of this model, we can also analyze the effects of other kinds of macroeconomic shocks, like the variances in foreign goods price  $p^*$  and foreign interest rate  $i^*$ . Besides, the dynamics of foreign reserves and the financial exchange rate caused by the portfolio adjustment that are subject to domestic residents' planned saving behaviour can also be analyzed. This model manifests flexibility by allowing us to examine the effects of any combinations of the accommodated variables.

However, there are also some points we do not cover in the model. First, we only analyze the effects of permanent changes in domestic credit and output. But the impacts on the economy of temporary economic policies also deserve attention at some times. Second, while discussing the effects of output movements, the case of  $\beta_1 < 1$  not investigated into and the prerequisites that determine the short-run dynamics of financial rate have not been explored.

Finally, despite some insufficiencies, the dual exchange rate model provides a framework to investigate the underlying working mechanism and the policy implication, particularly for those regimes with some degree of capital control.



## 6.5 Model application

It has to be admitted that the fixed exchange rate arrangement has contributed a lot to the continuous improvement of China's economic fundamentals. Nevertheless, this should not be seen as a reason for perpetuating such an exchange rate regime. With the gradual lifting of some protectionist measures that the World Trade Organisation (WTO) permitted and China was enjoying so far, like opening domestic financial market by the end of 2006 and lowering foreign commodity tariff inch by inch, the sustainability of such a fixed exchange arrangement albeit with strict capital controls is questionable.

The abrupt surges in the current account surplus and thereby the foreign reserves have been able to help China build up strong ability to withstand external risks and crises; however, they have been also producing some kinds of potential costs. Either domestic investment over-heating, or the inflation soaring, or the hang-up of domestic prices of oil and other staple raw materials, or even the obstinate issue of non-performing loans, all of them can be again connected back to the ex ante RMB exchange arrangement, and the engendered slack monetary condition.

The fast rising foreign reserves not only cause huge pressure on the currently maintained exchange rate regime but also render the efficacy of monetary policy gradually losing away. Excessive accumulation of foreign reserves lead domestic monetary base to enlarge inappropriately, and also press down domestic interest rate at a very low level. With the capital outflow still prohibited, the domestic equity market carrying on shrinking and the downturn of domestic consumption, the only

outlet for the superabundant domestic fund may be the investment.

If so, it will certainly stimulate the domestic investment to soar inappropriately. In the short term, over-investment will pull up the economic growth but will also raise inflation, especially the production factor prices while China still exercises price regulation of consumption products. If the rising factor price finally crushes such a price setting rule and drives domestic consumption price up, the pressure on the exchange rate to revalue is imaginably compulsive.

Moreover, immoderately cheap domestic credit further deepens the concerns on the NPL issue of domestic banking sector. After all, the enterprise profitability is at the core of any domestic risk. Without the support of strong profit margin of corporate sector, the issue of non-performing loan can only get worse but not better. Notwithstanding domestic price will go up shortly with increasing investment, the long-run trend of inflation is still unclear without a substantive improvement of domestic consumption component. If the current over-investment is ultimately transformed in to excessive ability of production in the future, then, where to find the way to exit such an over capability will be crucial. Resorting to either the international markets or domestic investment stimulus will only keep the current vicious circle running on.

However, to break such a dilemma, again we have to pin our hope on the exchange rate reform. The sticking point remains lying in the ex ante exchange rate regime. The vast amount of foreign reserves that China has accumulated so far cannot coexist permanently with its fixed exchange rate regime. The external disequilibrium of the

Chinese economy cannot last for ever. Sooner or later, the economy will embark on path of self-adjusting. China had better take initiative than be forced to do so. Empirically, when looking back at the history of China's exchange rate in the past decades, it is just a dynamic process of continual adjustment and reforms. The sustainable economic growth of China relies on sequential economic reconfiguration including the rearrangement of its exchange rate and monetary policy.

## 6.6 Empirical Findings and Conclusions

To accomplish the objectives, this study employed a quantitative approach to gather information that helps to meet the research objectives. The quantitative approach is represented by the econometric analysis of secondary data. (See Chapter Five)

The empirical part is applied to analyzing and interpreting the results obtained from the econometric analysis (time series analysis) (Structural VAR method) as the approach of the research methodology. This method includes many tests: selection of the lag length, unit root test, johanson cointegration test, impulse response function, and variance decomposition. These test were used to examine the impact of two type of macroeconomic shocks—real/supply, and nominal/demand shocks on output, and relative price. The estimation results are generally in line with theoretical priors.

The research hypotheses were set up in chapter five to examine the relationship between the exchange rate and a number of explanatory variables (domestic and foreign inflation rates, real-GDP and trade-openness ratio.). These hypotheses were

tested in chapter seven using structural VAR analysis.

The result indicated that there is a significant negative relationship between the Real Exchange Rate and Consumer Price Index of China. Moreover the relationships between Real Exchange Rate and Consumer Price Index of US, and also between Real Exchange Rate and Real-GDP are both positive. These findings are consistent with the results of similar techniques applied by the previous studies, Ahmed (2003) for Latin American economies, and Hoffmaister and Roldos (2001) for Korea.

From the results of structural VAR impulse response function (Figure 5.2), clearly we can see that the results are consistent with Purchasing Power Parity, the higher inflation rate in China, the more undervalued RMB. And also we can see that the lower inflation rate in US, the more undervalued RMB. Examining relative output, evidence shows that China's long term GDP growth leads to appreciation of RMB which is compatible with Balassa-Samuelson effect.

## 6.7 Limitations and Recommendations for Future Research

The main limitations are relative to the empirical analysis and data collection. The researcher faced some restrictions while gathering data for China, as monthly data were not available and so she used quarterly data for variables during the period 1994:1-2005:4, GDP quarterly data are also not available before 1994. And she also couldn't find the data for some variables like production rate, unemployment rate and so on for China. Therefore, the analysis could be restricted to five major variables.

While this study has provided valuable insight, further research could address,

several issues associated with the empirical analysis. The current study examined the impact of the relative nominal/ demand and real/supply shocks account for the variations in the real exchange rate changes during the estimation period. Although this research represents a start, more work needs to be done to sort out whether exchange rate flexibility would prove to be more useful for emerging market economics. A proper examination would be to estimate an econometric model to evaluate the degree of exchange rate misalignment, on the basis of which the case for exchange rate flexibility would be made. Because of data constraints this was not possible; however it would be a useful extension for the future.

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## Appendix A

### Exchange rate Determination, Theories, Evolution, and Models

#### A.1 Introduction

This chapter reviews some basic models exchange rate determination. Throughout the analysis, the exchange rate (Symbol  $S$ ) will be defined as the domestic currency price of foreign currency. So a rise in  $S$  means a rise in the price of foreign exchange, hence a relative cheapening of the domestic currency, or depreciation. Conversely, a fall in  $S$  implies a reduction in the number of units of domestic currency required to buy a unit of foreign exchange, that is, a rise in the relative value of the home country's money, or an appreciation. The Bilateral exchange rate between, say, the UK and USA is the price of dollars in terms of pounds. A change in the UK-US bilateral exchange rate in favour of the dollar could be indicative of either a decline in the international value of the pound or a rise in that of the dollar, or both. Mark price of dollars = Mark price of pounds / Dollar price of pounds.

Fixed exchange rate or pegged rate is a rate the government (central bank) sets and maintains as the official exchange rate. A set price will be determined against a major world currency (usually the U.S. dollar, but also other major currencies such as the euro, the yen, or a basket of currencies). In order to maintain the local exchange rate, the central bank buys and sells its own currency on the foreign exchange market in return for the currency to which it is pegged.

Unlike the fixed rate, a floating exchange rate is determined by the private market through supply and demand. A floating rate is often termed "self-correcting", as any

differences in supply and demand will automatically be corrected in the market. Take a look at this simplified model: if demand for a currency is low, its value will decrease, thus making imported goods more expensive and thus stimulating demand for local goods and services. This in turn will generate more jobs, and hence an auto-correction would occur in the market. A floating exchange rate is constantly changing.

In this chapter we review the exchange rate determinant under different model with consideration of monetary and fiscal policy. Three theoretical models are of interest- the monetary model, the Mundell-Flemming model, and the Dornbusch Model. These models are different with respect to their assumption on the rigidity of price. Generally in the long run prices are flexible whereas in the short run it is fixed. Given this assumption different models generate different exchange rate movement under monetary and fiscal policy as we can see below.

The rest of this chapter consists of several parts. Section A.1 introduces basic concepts. Section A.2 gives brief review on the historical evolution of the exchange rate since World War 2. Section 3 gives preliminary settings on open economy and financial market which are used in the models. Section 4 presents models and section 5 concludes.

## A.2 Exchange Rate since World War II: a brief History

### 1) *The Bretton Woods system: 1944-68*

Under the Bretton Woods system, countries undertook two major commitments: firstly to maintain convertibility and secondly to preserve a fixed exchange rate, until

unambiguous evidence of 'fundamental disequilibrium' appeared, at which point they were expected to devalue or revalue, as the case may be- in other words, announce a new parity. The Bretton Woods system worked on a principle known as the Gold Exchange Standard, which evolved from the pre-war Gold Standard. Under this arrangement the USA operated a fully-fledged Gold Standard, in other words it pledged to keep the dollar price of gold fixed irrevocably (at the price of 35\$ per ounce), by standing ready to exchange gold to US currency on demand via the so-called Gold Window. Other countries then fixed their currencies in terms of dollars, devaluing or revaluing as necessary in order to counteract disequilibrium, whether it was deemed to originate in their own deviant behaviour or in that of the USA. In other words, the USA anchored the system as a whole, by virtue of the fixed dollar price of gold. Other countries then had to accommodate themselves by changing their exchange rate when required.

## 2) *The Breakdown of Bretton Woods: 1968-73*

Broadly, the net demand for dollars shifted downward progressively throughout the 1950s and 1960s. In the event, the disintegration came in stages, starting in 1968 with the inception of an unofficial free market in gold, from which central banks were barred. The system finally broke down on 15 August 1971, when President Nixon announced the closing of the Gold Window. In the 1950s, while the fixed exchange rate system was at its most robust, the advocates of floating were relatively few, though they included the formidable figure of Milton Friedman. In the 1960s,

however, as national inflation rates began to diverge and the inconsistencies in Bretton Woods became increasingly obvious, the demand for a floating system appeared more and more attractive as a possible solution to the problems created by the incompatible macroeconomic policies of the major industrial countries. In particular, the argument that a floating exchange rate country behaves like a closed economy seemed convincing to many economists. A corollary of this view was that fears were largely groundless that floating exchange rates would be highly volatile.

### 3) *The floating rate era: 1973 to date*

The main features of the floating exchange rate period so far have been:

(i) A growing US current deficit, approaching \$200bn by 1987, by contrast, both Japan and West Germany enjoyed large surpluses in the 1980's.

(ii) Two massive increases in the price of Crude oil, engineered by the Organization of Petroleum Exporting Countries (OPEC) cartel, in 1973-4 and 1979. The first shock was accommodated by the fiscal and monetary policies of the oil-importing countries, and therefore led to accelerated inflation. The second shock, by contrast, was not accommodated, and was associated with a short, sharp recession in the USA and a more prolonged slump in Europe.

(iii) The problems of sovereign lending were further exacerbated by the third world Debt crises of the 1980's.

(iv) A perceptible acceleration of post-war trends in terms of the balance of economic power. By the end mid 1980s, Japan was in most respects the world's

largest trading nation.

(v) Much greater international capital mobility brought about technological advance, increasing internationalization of commerce and industry, and deregulation of capital markets in all the major financial centres.

For all these reasons, there is no justification for the conclusion that floating exchange rate regimes have somehow failed to deliver the tranquillity promised in advance by their advocates.

### A.3 The International Setting

#### A.3.1 Prices in the Open Economy: Purchasing Power Parity

The real exchange rate is far too volatile to be consistent with the constancy implications of *Purchasing Power Parity (PPP)*. It based on ‘no arbitrage argument’ or ‘law of one price’; PPP is a flow model of the ‘inflation theory of exchange rates’ vis-à-vis the balance of trade. Only relative PPP seems to hold in the long run. Shifts in technology, tastes, commercial policies or labour force growth will structurally change national *productivity* and hence will permanently change the real exchange rate. Hence, PPP is usually a benchmark currency valuation.

The Purchasing Power Parity (PPP) theory, sometimes called the ‘inflation theory of exchange rates’ can be traced back to the Salamanca school in sixteenth century Spain, and to the writing of Gerard de Malines appearing in 1601 in England. Though Keynes (1923, 1971) gave credit to David Ricardo for the concept of PPP, the Swedish economist Gustav Cassel (1918) was first to name the theory PPP. After World War I, Cassel became the outstanding protagonist of the theory. Cassel once

argued that without PPP, there would be no meaningful way of discussing over- or under- valuation of exchange rates. Basically, PPP relies on the 'law of one price' in an integrated, competitive 'product' market with an implicit assumption of a risk-neutral world. The concept is based on a flow theory of exchange rates where the demand for currency is to pay for exports and the supply is to pay for imports. Despite the fact that the theory has been known for centuries, PPP remains as controversial as ever. Much of the theory is reviewed and discussed by Officer (1984), Dornbusch (1988), Levi (1990) and Levich (1998).

When an asset market is taken into account, an interest parity condition, like PPP, follows the essence of international manifestations of the law of one price. In the absence of friction, the dollar rate of return on security investments, or the dollar costs of borrowing, will be equal in different countries where there is perfect capital mobility and perfect capital substitutability. Thus, interest parity, exchange rates and inflation rates are interdependent as discussed below:

### A.3.2 The Financial Markets in the Open Economy

#### A.3.2.1 Covered Interest Rate Parity

Covered interest rate parity (CIRP) states that there will be no advantage to borrow or lend in one country's asset market rather in that of another country. If there is an advantage, then interest arbitrageurs will move the market toward covered interest rate parity. Mathematically, the partial equilibrium equation based on arbitrage or 'law of one price' argument (in log form) is:

$$i - i^* = f - s$$

where  $i$ ,  $i^*$  are interest rate at home and abroad respectively,  $f$  is forward exchange rate and  $s$  is spot exchange rate. Empirically, Frankel and Levich (1975) using weekly observations from Jan. 1962 to Nov. 67 confirmed that CIRP holds. That is to say covered interest arbitrage does not seem to entail unexploited opportunities for profits. Later Frankel and Levich (1977) extended their studies into three periods : 1962-67, the ‘tranquil peg’; 1968-69, the ‘turbulent peg’; and 1973-1975, the managed float confirmed their previous study that CIRP still holds during these periods even though the effect of transaction costs is taken into account. They furthermore found that the cost of transactions (expressed in terms of widening bid and ask spreads) associated with CIRP increased dramatically during the managed float period compared to other periods. Clinton (1988) later examined CIRP and transaction costs with a similar conclusion. Moreover, one of Frankel and Levich (1977)’s conclusion is that transactions costs play a similar role in accounting for deviations from parity during ‘quiet’ periods, but not during ‘turbulent periods.

#### A.3.2.2 Uncovered Interest rate Parity

Resembling CIRP, it can be argued that an unhedged-interest-parity condition may hold in a rational expectations framework. The forward exchange rate may be strongly influenced by the market expectations about the future exchange rate, since participants’ currency expectations change as the result of new information. The interest rate spread between two substitutable assets with different currency denominations is equal to the difference between the expected future (log) exchange

rate and the current spot (log) exchange rate. Mathematically, UCIRP is (in log) at  $t = 0$  :

$$i - i^* = E [ s_{t+1} - s_t ]$$

where  $E [ s_{t+1} - s_t ]$  is expected changes in future rate and  $i, i^*$  are interest rate at home and abroad between  $t$  to  $t+1$  respectively. Very little empirical evidence supports UCIRP consistent with stylized facts on nominal exchange rate return by Vries (1994). Originally using a k-step-ahead forecasting equation and overlapping techniques on seven major currencies weekly data during the 1970's and 1920's, Hansen and Hodrick (1980) reject the simple market efficiency hypothesis for exchange; hence, UCIRP does not hold. Again Ito (1988) applies time-domain vector autoregression techniques and finds that UCIRP is rejected. Cumby (1988) later on asserts that the forward risk premiums are *time varying* with changing signs and question whether one should call it 'risk' at all. Finally, in the weak sense of UCIRP, expected changes in the nominal exchange rate should be positively related to the differences in the nominal interest rate across countries. But Adjaoute (1995) concludes that the risk premium arises in exchange because exchange risk is *not totally diversifiable*. From this cause, there are rewards for risk adverse investors for open positions in assets denominated in currencies other than their home currency. Alternatively, Bansel (1997) still finds UCIRP is violated in the weekly data for the U.S., Germany and Japan from January 1981 - May 1995 by using a generalized method of moment on a term structure model. Bansel claims one possible reason is each country may utilize different monetary policies over time.



## A.4 Consideration of exchange Rate Determination

### A.4.1 Flexible Prices: The Monetary Model

The monetary model is the earliest approach to explaining the related phenomena of exchange rate variations. It represents a benchmark for comparing the other approaches to modelling exchange rate determination, many of which grew out of the monetary model (such as Mundell-Fleming model and Dornbusch overshooting model which will be seen later in this section.). It consists of two basic building blocks: the purchasing power parity and the long run aggregate supply and demand relationship. The monetary model thus may be inadequate in explaining the short run exchange rate fluctuation; it nevertheless provides some useful insights into the broad picture of long term trends.

There are three essential assumptions on which the monetary model rests: First the aggregate supply curve is vertical. Thus any monetary or fiscal policy is impotent to affect the output, except the changing of productivity of the economy such as technology, human capital etc. Secondly, the vertical aggregate supply curve implies the perfect price flexibility. The demand for money is a function of only price level and real output:

$$M^d = kPy \quad (\text{A.1})$$

where  $M^d$  is the nominal money demand,  $P$  is the price level,  $y$  is the real output, and  $k$  is the positive parameter. Given the money supply is  $M^s$  the equilibrium implies:

$$M^s = kPy \quad (\text{A.2})$$

Thus it follows that the nominal output,  $Y$ , is constant along the aggregate demand

curve. More importantly given the increase of money supply say doubling the money stock, the outcome has to be a shift of AD curve outward that doubles the nominal output, since real output is fixed by long run vertical AS curve it must be the case that the price level is doubled. Thirdly, purchasing power parity must hold at all time. Two price levels follow the relationship as:

$$SP^* = P \quad (A.3)$$

where  $P^*$  is the foreign price level. The PPP implies that economy cannot gain from international trade and purchasing power of each country's currency must be the same. Consider left diagram of figure A.1, where the purchasing power parity relation lies in the  $P, S$  plane. The ray from the origin is the locus of all combinations of  $S$  and  $P$  that satisfy PPP relation we call it PPP line. The slope of the line is just the foreign price level. We can see that any point above the line makes domestic economy uncompetitive since the domestic price level is relatively high, it is better off importing from the foreign country. In terms of real exchange rate ( $Q$ ):

$$Q = SP^*/P \quad (A.4)$$

It means for purchasing power parity to hold it must be equal to one. Hence the relatively high domestic price level indicates the real appreciation of the exchange rate. In contrast any point indicates the competitiveness of the domestic economy is below the line.

Recalling the money market equilibrium equation A.2 and purchasing power parity relation, we can combine these two equations into:

$$M^s = kPy = k_y SP^* \quad (\text{A.5})$$

So we can solve for S:

$$S = M^s / kP^*y \quad (\text{A.6})$$

The exchange rate is determined by three variables: foreign price level, real domestic output and domestic money stock. Next we will consider the effect of these variables under fixed and exchange rate regime.

**Under floating exchange rate:**

*A monetary expansion:* considering the increase of money stock, assuming other variables are unchanged. The AD curve shifts outward. Equation A.2 gives us the explicit indication that since the real output stay constant given the increase of money supply the domestic price level must increase the same proportion. Figure A.1 shows that at initial price level  $P_0$  there must be excess supply of money which cause economic agents to increase spending so as to reduce their money balance by buying goods or services. Given the real output stays constant the extra spending must drive up the price level to  $P^1$ .

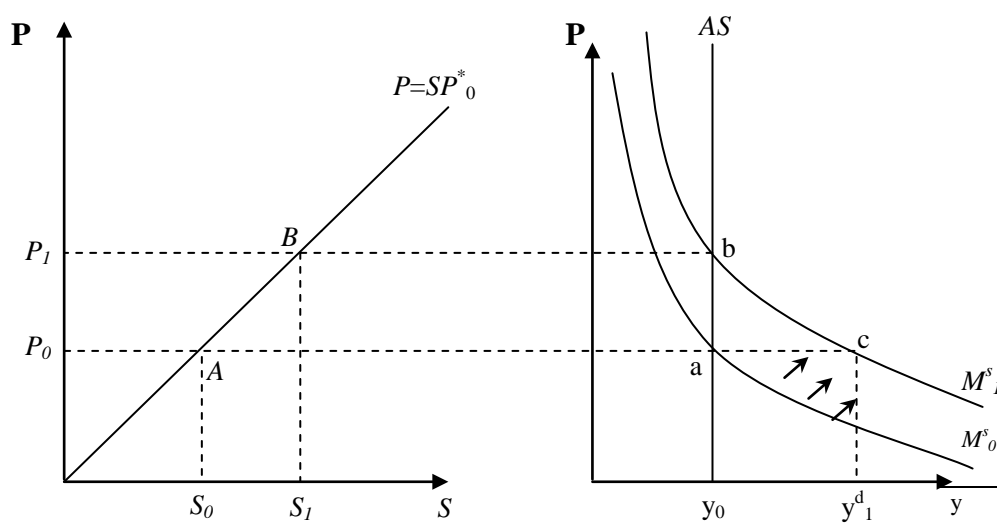


Figure A.1

As the price of domestic goods rises, price of foreign currency must increase in order to keep domestic output competitive. Hence the nominal exchange rate increases from  $S^0$  to  $S^1$  corresponding to the PPP line from  $A$  to  $B$ .

In the monetary model, assuming other things being equal, a given percentage increase in the domestic money supply leads to a depreciation of the same proportion in the value of the domestic currency.

*An increase of real income:* the change of real income only can be done by the shift of long run AS curve. Figure A.2 demonstrates the effect of increase of real income. A higher real income implies a greater demand for money. With a given money supply the nominal income must be constant, thus the higher is real output the lower must be the price level. The price level changes from initial level  $P^0$  to  $P^1$  otherwise if the price level stays constant the nominal income will be at point  $c$  where there is excess demand for money and excess supply for goods.

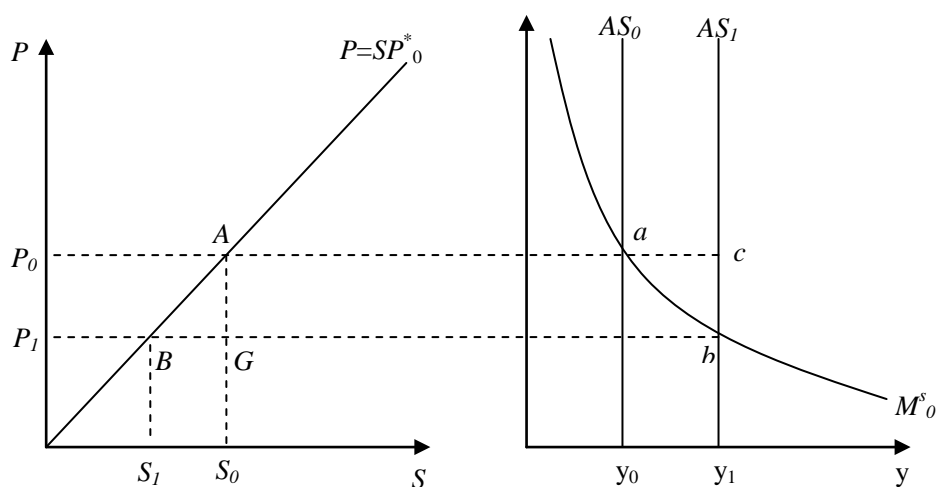


Fig A.2

Therefore the result must be deflation at the point  $b$ ; all the markets are at equilibrium. To ensure PPP must hold, the lowered domestic price level must lead to the fallen exchange rate from  $S^0$  to  $S^1$  hold foreign price. Otherwise the fall of in domestic prices would have made domestic economy competitive, causing a massive excess demand for domestic currency. PPP is preserved by exchange rate appreciation, so that the fall in the price of domestic output is offset by a rise in the price of domestic currency.

The result of real income increase hence is that since it swells the demand for money, it must cause a contraction in the demand for goods, which in turn must lead to a fall in the domestic price level, holding money supply and foreign price level constant, the home currency must appreciate.

*A foreign price increase:* having mentioned above the foreign price level  $P^*$  is the slope of the PPP line. Thus the increase of foreign price level leads to the steep of the

PPP line, so that the original domestic price level  $P^0$  is associated with a lower price of foreign currency thus domestic currency appreciates. Figure A.3 shows that with higher foreign price level, domestic goods are competitive at the old exchange rate. The demand for domestic currency by foreign importers drives up the domestic currency price until the foreign and domestic economies are equally competitive. In the new equilibrium point  $B$  the higher foreign price level is offset by the higher relative price of the domestic currency. The foreign price change under monetary model has significant proposition which suggests that world inflation need have no impact on the domestic economy. The domestic price level is determined in home money markets exactly the same way it would be. Copeland (1989) suggests that under monetary model the floating exchange rate acts like a valve, continually sliding up or down as required to preserve PPP in the face of disturbances originating in either or both countries' domestic money market. Thus the implication is that each country's macroeconomic policy is independent because of the exchange rate flexibility. Its independence is to be regarded as a desirable feature of an international monetary order; the floating exchange rate system appears highly attractive.

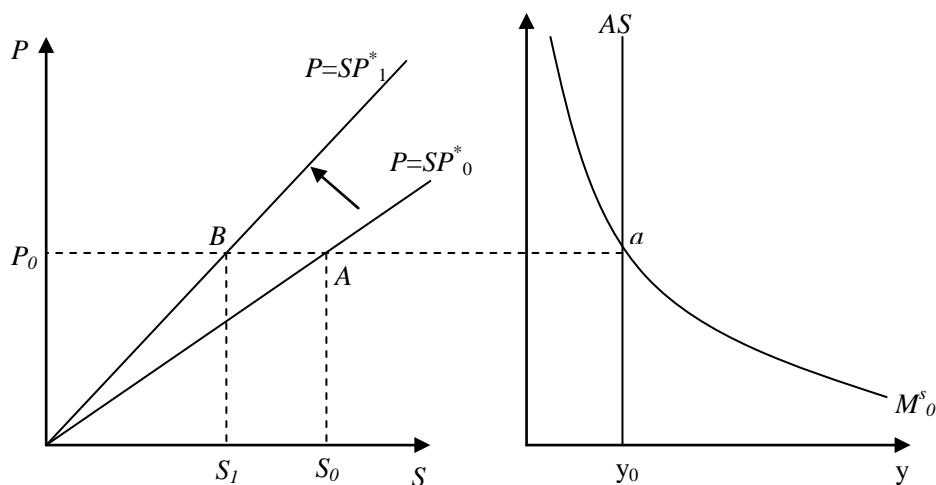


Figure A.3

**Under fixed exchange rate:**

Consider a situation where the exchange rate is fixed. Unlike the case in floating exchange rate, here the money supply is an endogenous variable where money supply is the sum of foreign currency reserves ( $FX$ ) and domestic credit ( $DC$ ):

$$M^s = FX + DC \quad (A.7)$$

In order to keep the exchange rate fixed central bank has to manipulate the volume of foreign currency reserve, in turn will affect the domestic money supply. The right diagram of figure A.4 plots the money stock change in the  $M^s$  and  $FX$  plane. The intercept is thus the domestic credit, and the slope of the ray is one. The ray shows how the money stock increases with additions to the reserves, given the initial quantity of domestic credit.

*A monetary expansion:* figure A.4 shows that the initial foreign reserve and money supply is at point  $H$ .

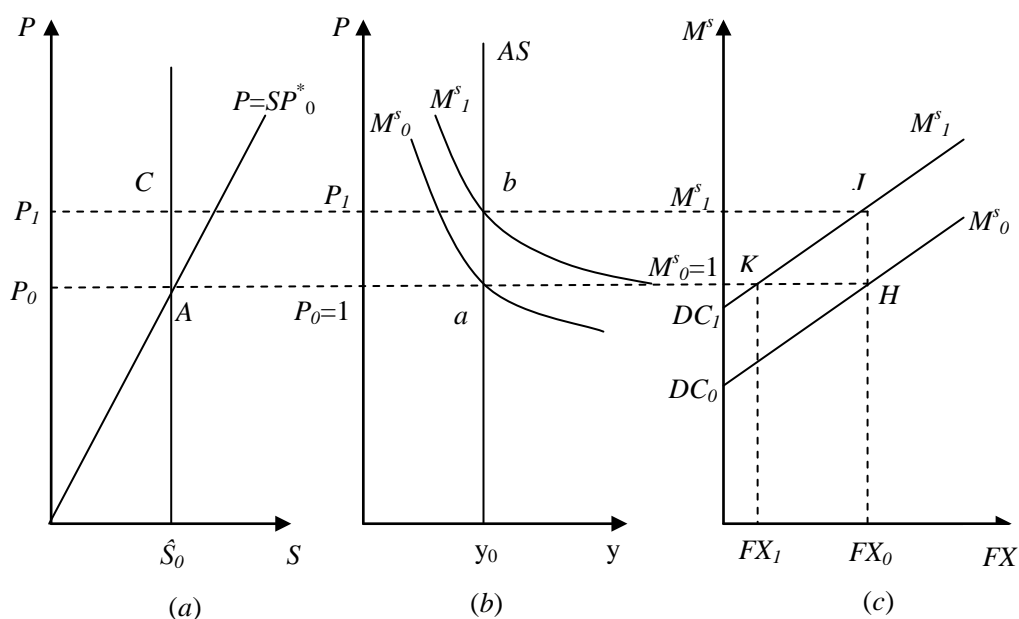


Figure A.4

In order to link figure A.4.b and A.4.c we set the value of money supply and the price level equal. As with the floating exchange rate case, the left diagram plots the PPP line, however with the exchange rate fixed hence  $S$  always pegs at  $\hat{S}_0$ . Since the equilibrium requires the economy should be at PPP line, it follows that the domestic price level must end up at point  $A$  where it is the intersection of the PPP line with the fixed exchange rate line. Thus the initial equilibrium is shown at points  $A$ ,  $a$  and  $H$ . The effect of money supply increase by increasing domestic credit shifts the intercept from  $DC_0$  to  $DC_1$ ; the money stock now is  $M^s_1$  at point  $J$ . the new money stock implies a increased price level  $P_1$ . The new price level implies that the domestic economy is uncompetitive, given unchanged foreign price and the fixed exchange rate. At point  $C$  there is an incentive for domestic firms to import from abroad, thus the outcome must be the current account deficit and the depreciate tendency for the



domestic currency. To tackle this downward trend of exchange rate central bank must use foreign reserves to buy the domestic currency. The result is that the reserves start to fall, in turn money supply decreases. Therefore, the system moves from  $J$  to  $K$ , from  $b$  back to  $a$ , and from  $C$  down to  $A$ . the process ends up with competitiveness restored, back at  $A$  on the PPP line. Under fixed exchange rates, domestic credit creation will be neutralized, given other variables being constant, by a fall in the reserves as a result of a temporary current account deficit. Conversely, domestic credit contraction will cause a temporary balance of payments surplus and a consequent offsetting rise in the reserves.

*An income increase:* with the price level unchanged, an increase in real income leads to a rise in the demand for real money balances, then the impact will cause domestic residents to spend less. In doing so, there is excess supply in goods market that force the price level down, which with a fixed exchange rate makes the home country's output competitive on world markets, leading to a balance of payments surplus, thus rise in the foreign reserves. This process will end up when the domestic money stock has grown enough to match the demand. Under fixed exchange rate, the result of a rise in real income will cause an increase in the reserves as a result of temporary balance of payment surplus. In the new equilibrium the domestic money stock has risen and the home price level decrease back to PPP line.

*A foreign price increase:* as for a foreign price level rising, the PPP line will be steeper. The effect under a fixed exchange rate is to increase the home country's

competitiveness, causing a payments surplus and consequently increase of the foreign reserve. This in turn brings about a rise in the money stock, pushing up the home country price level until it reaches the equilibrium of purchasing power parity. Starting from a position of equilibrium, the result of a rise in the foreign price level will cause an increase in the reserves as the result of a temporary balance of payments surplus, given other variables being fixed. The new equilibrium implies the domestic money stock will be greater, and the home price level will have risen. Unlike floating exchange rate, the foreign price change implies that domestic economy has to import inflation from the rest of the world. The fact that it cannot control its own money supply means it cannot choose its price level or inflation rate independently. The important conclusion is that a country cannot follow an independent monetary policy under fixed exchange rates nor can it choose a price level or inflation rate different from that of the rest of the world.

*The use of devaluation:* A fixed exchange rate regime is sometimes referred to as an adjustable peg, monetary authorities can adjust the domestic currency price aiming to gain competitiveness in goods market. We will then see the effect of devaluation of currency price under monetary model. Figure A.5 shows the effect of devaluation, once and for all rises in the price of foreign currency.

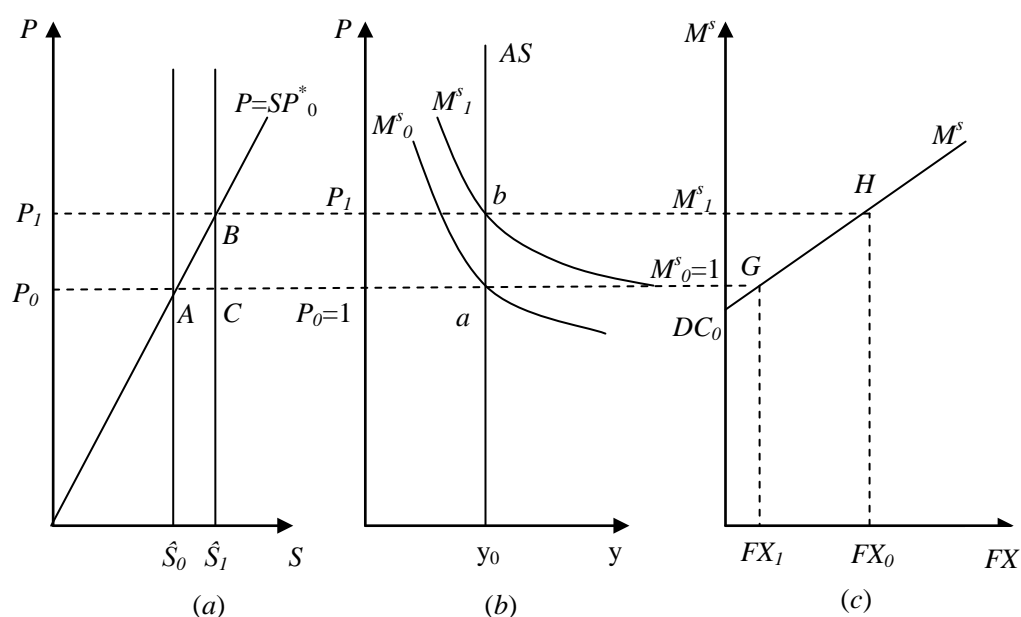


Figure A.5

Suppose the economy starts off in equilibrium at points  $A$ ,  $a$  and  $G$  in the three graph. The initial exchange rate is fixed at  $\hat{S}_0$ , a price level under PPP of  $P_0$  and a money supply of  $M_0^s$  is the sum of domestic credit  $DC_0$  and reserves of  $FX_0$ . The home country then devalues the domestic currency price to  $\hat{S}_1$ . The short term impact is to move the economy instantaneously to a point like  $C$  where home economy is now over competitive. With both domestic and foreign price level unchanged, the increase of the nominal as well as real exchange rate makes the foreign goods artificially expensive, while domestic goods are unchanged in price. The result must be a tendency for home country consumers to buy more domestic output than previously. Conversely, foreigners find the home country's products more attractively priced than prior to the devaluation. The outcome has to be a balance of payments surplus. This surplus leads to the accumulating foreign reserves, hence the domestic money supply increase from point  $G$  to  $H$  in the figure A.5.c. Since the volume of domestic credit is

unchanged, the money supply must be growing, shifting the aggregate demand curve upwards. In terms of the money market, with real income and output constant, hence the price level must be higher as agents attempt to reduce their excess real balances by buying additional goods. As the price level rises the competitive advantage is eroded, until the new equilibrium is reached at *B* in the PPP line. In terms of the goods market, if output is fixed, the increased demand by domestic residents and by foreigners cannot be satisfied. The excess demand must generate an inflation, which persists until enough of the additional demand has been priced out of the market in order to restore equilibrium.

Thus under fixed exchange rates the result of a devaluation will be a temporary improvement in the competitiveness of the home country and consequently a balance of payments surplus, leading to a rise in its foreign currency reserves. However, the accompanying inflation will emerge; hence erode the country's price advantage, until economy move to a new equilibrium where it is with higher price level, greater reserves and a larger nominal money stock, but the same real money supply.

#### A.4.2 Fixed Prices: The Mundell-Fleming Model

The Mundell-Fleming model is consistent with Keynesian tradition- aggregate supply curve is flat which takes the passive role of fixing the price level, while aggregate demand variations determine the level of economic activity. It means that we can concentrate on the demand side of the economy. Since output adjusts passively, the *IS-LM* framework is used in which aggregate demand is determined.

The distinctive feature of the Mundell-Fleming model is the current balance is determined independently of the capital account, so that the achievement of overall balance requires adjustment in the domestic economy. The model assumes that the purchasing power parity does not hold, even in the long run. Instead, the current account ( $CA$ ) depends positively on the real exchange rate ( $Q$ ) and negatively on real income ( $y$ ):

$$CA = F(y, Q) \quad F_y < 0, F_Q > 0 \quad (A.8)$$

Given both domestic and foreign price levels, the real and nominal exchange rates are in fact identical. The role of interest rates is central to the model. Here we assume that capital mobility is imperfect which means international interest rate differentials are assumed to provoke finite flows into or out of a country. Given the foreign interest rate ( $r^*$ ), the capital account ( $KA$ ) surplus depends positively on the domestic interest rate where:

$$KA = K(r - r^*) \quad K_r > 0 \quad (A.9)$$

The equation implies that the domestic capital inflow is an increasing function of the extent to which the home interest rate is greater than the one ruling in foreign country. It should be noted that in the Mundell-Fleming model the current account does not need to balance neither in short or long run. The current account deficit (surplus) can be offset by a capital account surplus (deficit) of the same size. Therefore balance of payment should be always at equilibrium which obtains when the flow of capital across the exchanges is just sufficient to finance the current account deficit or absorb the surplus. This means that the sum of depends on the surplus on capital and current

account must be zero. Thus adding equation 8 and 9 the following condition to apply at all times:

$$CA(y, Q) + KA(r - r^*) = 0 \quad (\text{A.10})$$

Consider Figure A.6, the *BP* line plot the combinations of  $y$  and  $r$  consistent with balance of payments equilibrium for different values of  $S$ . The upward sloping line implies as income increases at any given exchange rate, the current account deteriorates as import demand grows, in order to preserve equilibrium, the capital account must improve by increasing the domestic interest rate. Thus higher income must be associated with higher interest rates for balance of payment equilibrium and vice versa. The extent of the interest rate increase required to offset a small rise in income depends on the interest elasticity of net capital flows. Under the assumption of perfect equilibrium the slope of *BP* line will be zero (flat). On the other hand, a rise in domestic currency price means a current account surplus, and hence requires a more capital inflow, and thus a lower interest rate. Thus increases in  $S$  will shift the *BP* line downward. However if the line is flat, domestic interest rate must be equal world interest rate at all time in order to prevent the flood of capital into or out of the country. We then consider the effect of expansionary monetary policy and fiscal policy under floating and fixed exchange rate.

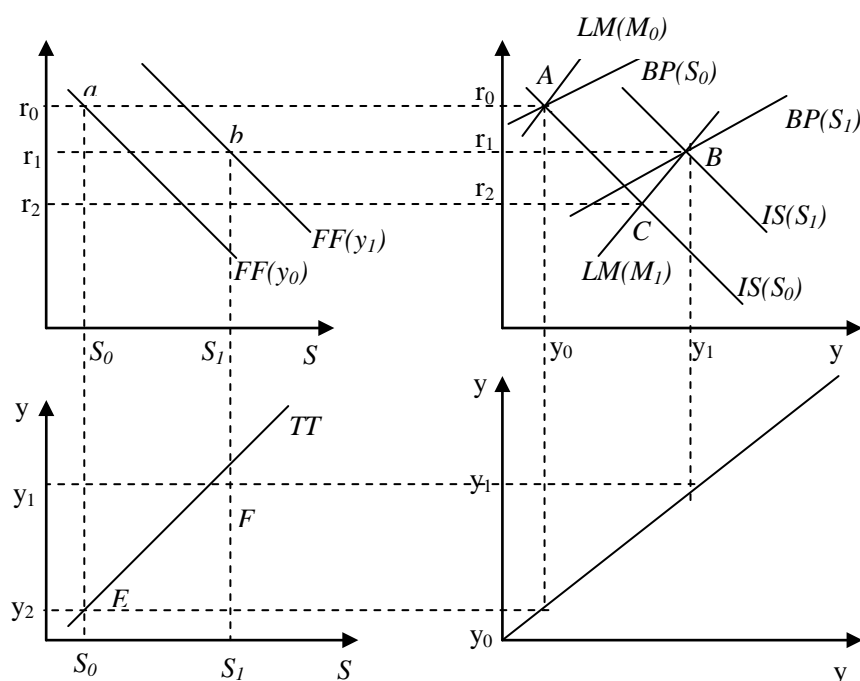


Figure A.6

### Under floating exchange rate

*Monetary expansion:* suppose the  $IS$ ,  $LM$  and  $BP$  curve is initially at equilibrium at point  $A$  in figure A.6. The monetary authority decides to double the money stock. Since the price level is fixed, the increase in the nominal money stock is equivalent to a rise in the real money stock. Hence the  $LM$  curve moves downwards, so that the interest rate has to fall. At first the  $LM$  can shift as far as  $r_2$ . However the point  $C$  is not an equilibrium point because with a lower interest rate the capital inflow is smaller than it was before the monetary expansion. At the higher real income level, the current account balance must be deteriorated. Thus at point  $C$  the balance of payment is disequilibrium. Since the domestic interest rate is lower than world interest rate the domestic currency price will depreciate for the sake of capital outflow. As exchange rate depreciates, the competitiveness of domestic production improves and demand for domestic output increases, shifting the  $IS$  curve outwards to  $IS_1$ . The

boost to demand has the effect of pushing interest rates part of the way back to the original level. Finally the economy settles at  $B$  where the interest rate is at the level  $r_1$ . Balance of payment is back to equilibrium because the moderate increase of the interest rate has the effect of reducing the capital account deficit to a level where the current account surplus created by the depreciation in the currency is sufficient to cover it. Thus under the floating exchange rate the monetary expansion leads to a depreciation in the exchange rate and an increase in income. Moreover, the an improvement in the current account and capital account deficit because of the lower interest rate ensure the balance of payment is zero.

*Fiscal expansion:* By contrast, Figure A.7 illustrates the effect of a pure fiscal expansion e.g. an increase in government expenditure. Given fixed money stock and constant price level the  $LM$  curve therefore does not move at all. Whereas, fiscal expansion shifts  $IS$  curve to the right. However since money stock is fixed, the government can only finance its spending by borrowing. Since we assume all the markets are at equilibrium, borrowing is only feasible at the cost of a higher interest rate. The impact of the fiscal policy is to increase income and the interest rate. However, point  $C$  in the figure is inconsistent with equilibrium in the balance of payment. A higher interest rate implies an influx of capital into home country, accordingly an emerging excess demand for domestic currency leads to the price of the domestic currency must appreciate. As the exchange rate rises, domestic goods becomes less attractive to foreigners, shifting the  $IS$  curve back down to the left, and



pushing the interest rate some of the way back to its initial level. The process ends when the combination of exchange rate and interest rate are such that domestic equilibrium is at point  $B$ . consider the balance of payment the outcome is a current account deficit and capital account surplus. The interesting case here is if we are facing perfect capital mobility. When the  $BP$  is flat, the  $IS$  cannot move in the long run. The reason is with  $BP$  and  $LM$  curves fixed the interest rate cannot change; the system must remain at the point  $A$  in the  $IS-LM$  diagram. It follows the exchange rate must move so as to keep the  $IS$  curve unchanged, that is enough to offset the expansionary effect on demand of the increase in government spending. Thus with the interest rate pegged by international capital markets, the adjustment falls totally on the exchange rate which has to appreciate enough to generate a current account deficit.

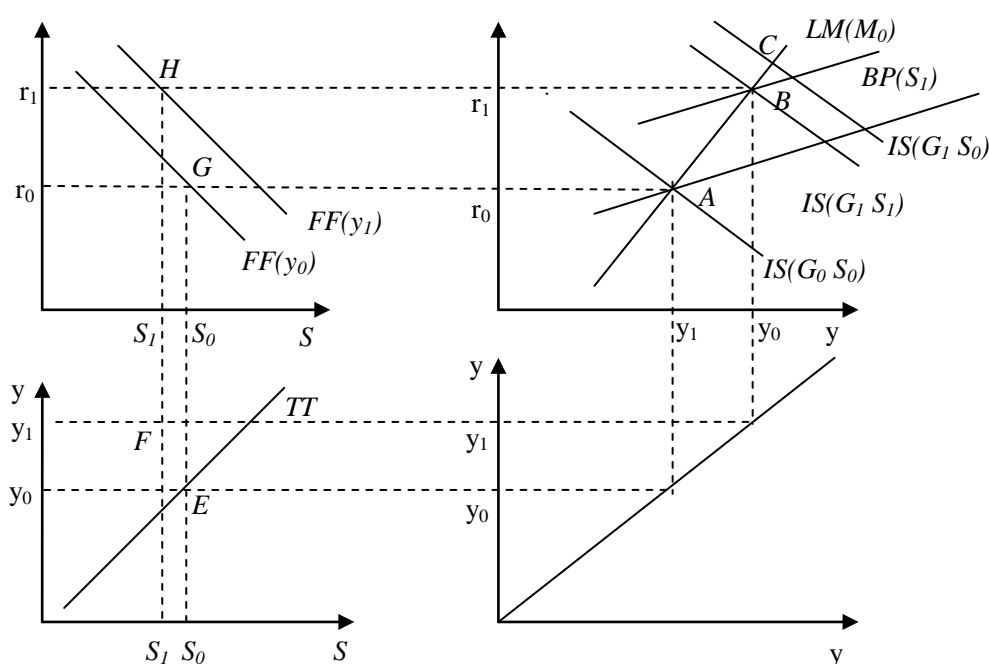


Figure A.7

Consequently, fiscal expansion cause an appreciation in the exchange rate which causes current account deficit, an increase in income if capital is not completely mobile. Also with imperfect capital mobility a rise in the interest rate provide capital account surplus.

### **Under fixed exchange rate**

*Monetary expansion:* let us focus on fixed exchange rate regime. In figure A.8 the initial equilibrium is at *A*. Consider the effect of monetary expansion. The impact effect of the increase in the total money stock has to be the downward shift in the *LM* curve, thus the new equilibrium is at point *B*. Concerning the balance of payment equilibrium, the fall in the interest rate must worsen the capital account balance, at the same time the increase in income with an unchanged exchange rate also causes deterioration in the current account. Thus point *B* cannot be an equilibrium point because the overall balance of payment deficit and excess supply of domestic currency means that the fixed exchange rate can only be preserved by running down the foreign reserves. The process only ends when the money stock is back where it starts at point *A*. Although at the new equilibrium interest rate, income and the balance of payment are back at the previous level, yet the composition of the money stock is now made up of a lower quantity of foreign currency, and a greater quantity of domestic credit. In the extreme case i.e. with perfect capital mobility it must be assumed that any fall in the interest rate is ruled out since it would provoke an immediate run on the foreign currency reserves. So the adjustment process would be instantaneous. The conclusion is in the short term; given capital is not perfect mobile,

the interest rate falls, income increases and the balance of payment deficit on both current and capital account. In the long run a fall in the foreign currency reserves, but there are no change in income, the interest rate.

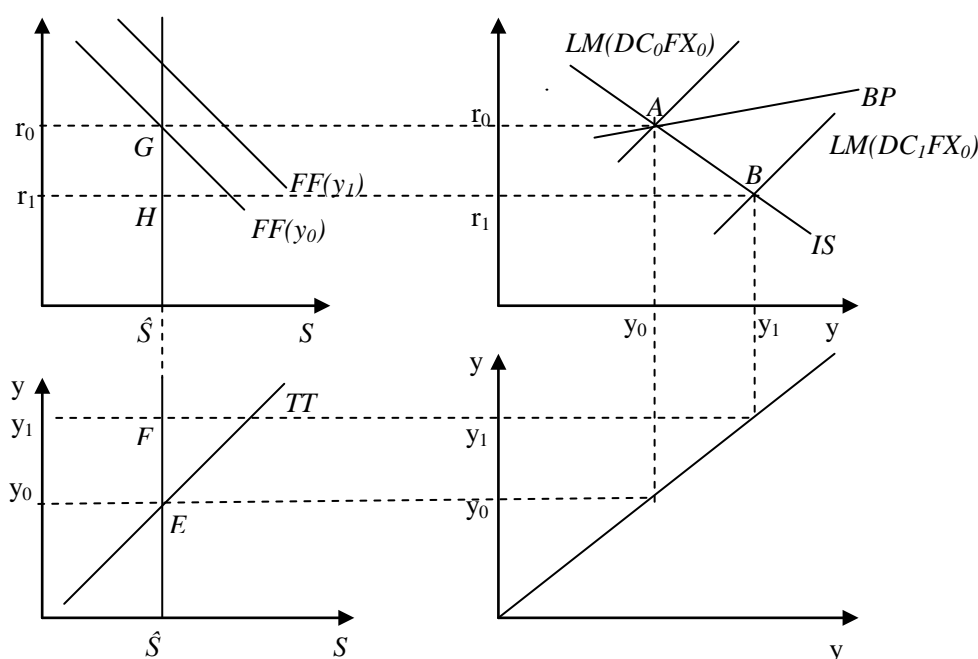


Figure A.8

*Fiscal expansion:* finally we see the effect of government spending financed by borrowing in the context of a fixed exchange rate. Consider figure A.9 the effect is firstly to shift to  $IS$  curve upward. The interest rate must rise as the government try to expand their borrowing, the  $IS$  curve intersects the unchanged  $LM$  at  $C$ . However, point  $C$  is not long run equilibrium. The higher interest rate improves the capital account by more than the deterioration in the current account brought about by the increase in income. Again the solution lies in a change in the domestic component of the money supply which as foreigners takes advantage of the high domestic interest rate by buying home currency. In the process, home exchange rate has the tendency of

appreciation, to keep exchange rate fixed the monetary authority must buy more foreign reserves, thus the domestic money stock swells which leads to the  $LM$  curve shift down to generate a long run equilibrium at  $B$ , where the further increase in income and fall in the interest rate worsen both current and capital account sufficiently to bring balance of payment equilibrium. The outcome is a balance of payment that shows a deficit on current account and capital inflow attracted by the relatively high domestic interest rate.

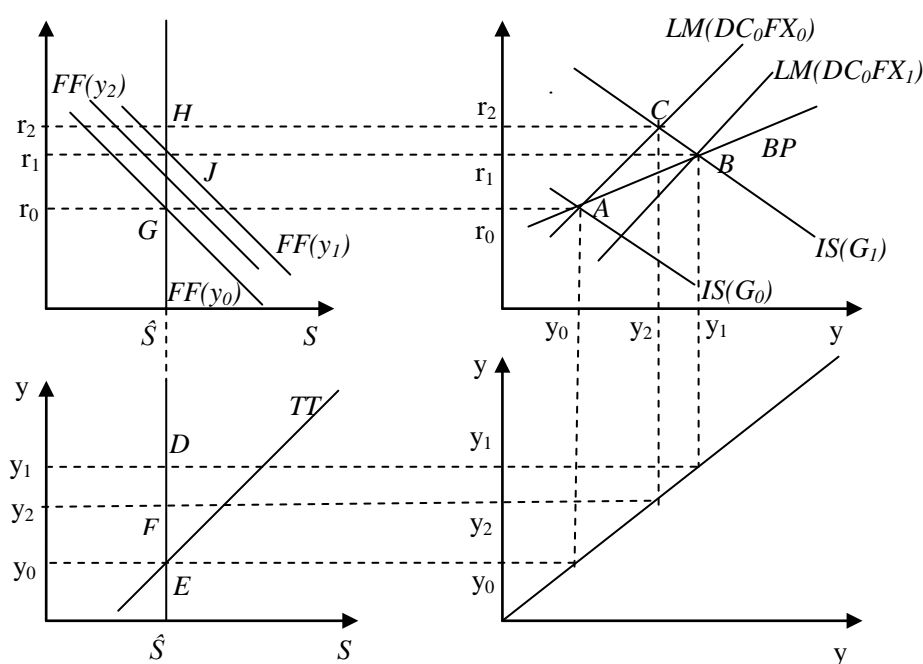


Figure A.9

The general conclusion is that in the short run a rise in the interest rate and income, and an overall surplus on the balance of payment. In the long run a further increase in income, interest rate falls and the overall balance of payment shrinks to zero, leaving a substantial current account deficit. Under the assumption of perfect capital mobility the domestic interest rate will equate the world interest rate, also the real income will

be increase further.

#### A.4.3 Sticky Prices: The Dornbush Overshooting Model

As we have seen above, both monetary model and Mundell-Fleming model have their drawbacks. The monetary model is incapable of explaining the facts because it relies on the unrealistic assumption of purchasing power parity and it ignores the role of played by expectations. In particular the day-to-day exchange rate fluctuation is far more violent than could be explained by the movements of relative money stocks and national incomes. The Mundell-Fleming on the other hand also does not take account of expectations, and it assumes a fixed price level which cannot explain the long run trend of exchange rate movement. The Dornbush model in contrast is a hybrid of these two models in which it fits into the Keynesian tradition assuming the stickiness of prices in the short run, and it also displays the long run features of the monetary model. The model is based on the observation that when product markets adjust slowly, financial markets appear to adjust for more rapidly. The consequence of allowing for this feature of the real world turns out to be that financial markets have to over adjust to disturbances, in order to compensate for the stickiness of prices in goods markets. The reason is that, with goods prices initially fixed, a change in the nominal money stock, for example, amounts to a change in the real money stock. It follows that there has to be an instantaneous change in the demand for real balances if the money market is to clear, and the change can only be brought about by an upward or downward movement in interest rates if output is assumed fixed. However, the deviation of domestic interest rates from world levels can only be temporary. As

product prices begin their delayed response, the change in the real money stock starts to reverse itself, and with it, the whole process goes into reverse, driving interest rates, aggregate demand and the real exchange rate back to the initial values.

More specifically the Dornbush model assumes that financial markets adjust instantaneously. In particular, investors are risk neutral, so that uncovered interest rate parity holds at all times. In other words:

$$r = r^* + \Delta s^e \quad (\text{A.11})$$

where  $r$  is the domestic interest rate,  $r^*$  is the world interest rate, and  $\Delta s^e$  is the expected rate of depreciation in the value of the domestic currency relative to the foreign currency. The way of exchange rate expectation determination is essential for the model. It assumes that there exists a long run equilibrium exchange rate  $\hat{s}$  which is assumed to be determined at any moment by the level of domestic money stock, national income and interest rate relative to the world. In the Dornbush model the exchange rate is assumed to be at its equilibrium level only in the long run, the in short run it will deviate from its equilibrium level as a result of the sluggishness of goods market reaction. When the exchange rate is below its long run equilibrium level its future path will be a upward direction towards equilibrium and vice versa when its above equilibrium. Moreover the exchange rate will be expected to converge quicker on its long run level the greater the distance it has left to cover. The expectations mechanism can be expressed as:

$$\Delta s^e = \theta(\hat{s} - s) \quad (\text{A.12})$$

The equation is taken by natural logarithm. The right hand side is the gap

between the logarithm of the actual exchange rate and the logarithm of the long run exchange rate. The parameter  $\theta$  is the sensitivity of market expectations to the over or under valuation of the currency relative to equilibrium. The greater it is, the more rapidly the exchange rate is expected to depreciate for any given degree of overvaluation.

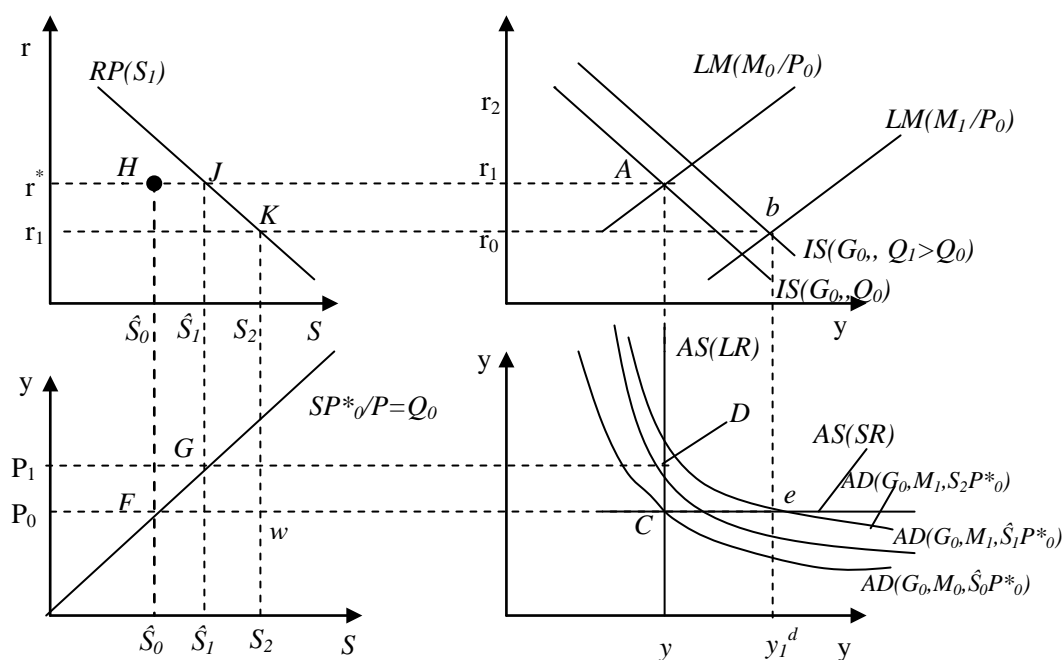
As for goods market, the price level is sticky. In other words, the aggregate supply curve is horizontal at the beginning, increasingly steep in the adjustment phase, and eventually vertical in the long run equilibrium. In the long run, the exchange rate is at its equilibrium level, in other words its market clears. However, in the short run the price is fixed due to the rigidities of the labour and goods markets caused by e.g. long run contract. As a result shocks which move the nominal exchange rate are associated with changes in the real exchange rate. The economy moves back to its long run real exchange rate, as a result of movement in both the nominal exchange and the price level.

### **Monetary expansion an illustration**

We now consider the effect of an unanticipated money supply increase in the short run and long run. Like the monetary model, the monetary expansion has no real effect on the economy in the long run. The vertical aggregate supply curve  $AS (LR)$  implies that the aggregate demand has to equal the natural rate of income. The interest rate will have to equal world interest rate  $r^*$  since long run equilibrium requires no further change in the exchange rate. Having seen in the monetary model the effect of change

in money supply is offset by the same proportion change in the domestic price level thus leaving the real money supply unchanged. In the long run the purchasing power parity also holds, implying the nominal exchange rate must also increase by the same proportion to the price level which ensures that there is neither a surplus nor a deficit in the current account of the balance of payments. Thus the new equilibrium is at point  $G$ ,  $D$ ,  $J$  and  $A$ .

Figure A.10



Having measured the long run effect of money supply we now work out the impact effect. Consider the IS-LM diagram figure A.10 where it can be seen that the LM curve shifts down because with the nominal money stock increased and the price level unchanged, the real money supply is increase. With national income unchanged and the real money stock grater than before, there would be an excess supply of money at the old interest rate  $r^*$ . Since financial markets clear at all times, any



incipient excess supply of money will be instantaneously choked off by a fall in the interest rate, offsetting the increase in the supply of real balances by a compensating increase in the demand. To prevent the flood of money out of domestic economy, there needs to be some compensating attraction for holders of domestic securities. Assuming the uncovered interest rate parity always holds the compensation is provided by an instantaneous depreciation in the exchange rate to a point at which the market views the pound as being undervalued as to offer the prospect of appreciation sufficient to offset the lower interest rate on domestic securities. However, the fall in the interest rate is mitigated by an induced shift in the *IS* curve. Since the nominal exchange rate has fallen while the domestic price level fixed, the competitiveness of home economy has improved, stimulating demand for its output and pushing the *IS* curve to the right. The net effect is to leave the economy in short run equilibrium at point b where the interest rate has fallen to  $r_1$  and aggregate demand has risen to  $y_1$ . With an interest rate lower than world interest rate, the temporary exchange rate must be higher than the new long run exchange rate. Having said above in the long run the monetary expansion will cause price level and nominal exchange rate increase by the same proportion. Thus the temporary exchange rate needs to overshoot in order to generate the negative expected rate of depreciation in the value of the domestic currency. On balance the domestic currency is going to appreciate by just enough to compensate for the lower interest rate on home deposits in other words, at the rate  $r^* - r_1$ .

Turning to the adjustment process, the excess demand for goods and services will

tend to push up prices in the domestic economy, at a speed which will depend on the rapidity with which the individual product and labour markets respond. As prices rise, the excess demand is eliminated in two ways. First, the domestic temporary competitive advantage is gradually eroded by the rise in domestic prices, so the demand for home output is reduced, the *IS* curve shifts back towards its original position. Secondly, the real money supply is progressively reduced by the inflation, shifting the *LM* curve back to its initial position. As the real money stock falls back, the interest rate rises to choke off the additional demand for money. As the domestic interest rate rises, the exchange rate appreciates, further eroding the home's competitive advantage. In general the adjustment phase is the process of firstly domestic currency is appreciating in diminishing rate, secondly a decreasing current account surplus, thirdly decelerating price inflation and finally a rising interest rate.

We now extend the Dornbush model further to somewhat formal explanation. First, we set down the equations.

$$r=r^*+\Delta s^e \quad (\text{A.13})$$

$$\Delta s^e=\theta(\hat{s}-s) \quad (\text{A.14})$$

$$m-p=ky-lr \quad (\text{A.15})$$

$$y^d=h(s-p) \quad q=s-p \quad (\text{A.16})$$

$$\Delta p=\pi(y^d-\hat{y}) \quad (\text{A.17})$$

All the equations are taking logarithms terms. We are familiar with equation A.13 and A.14 above. Equation A.15 is simply a log linear formulation of the demand for money where it depends positively on real income and negatively on real interest rate. The important implication is since the money stock is given exogenously, thus money

demand is equal money supply. Equation A.17 is simplified aggregate demand. The equation captures the essential link between aggregate demand for domestic output and the log of the real exchange rate which is  $q=s-p$ , assuming foreign price level is unity. The higher the real exchange rate, the more competitive are domestic products. Equation 17 is a price adjustment equation which says that the wider the gap between demand and natural output the higher the rate of inflation,  $\Delta p$ . The equations above can be reduced to two equations. Substituting from equation A.13 and equation A.14 to eliminate the domestic interest rate from the demand for money equation A.15 we have:

$$p=m-k\hat{y}+lr^*-l\theta(\hat{s}-s) \quad (\text{A.18})$$

and using equation 16 to replace aggregate demand in equation A.17:

$$\Delta p=\pi(hs-hp-\hat{y}) \quad (\text{A.19})$$

In long run the inflation is zero, thus:

$$s-p=Q=\hat{y}/h \quad (\text{A.20})$$

where  $Q$  denotes steady state values of real exchange rate. In the long run the only thing in the model which changes the real exchange rate is growth in natural output. Otherwise any change in the nominal exchange rate is matched by a change in the price level. Also the expected rate of depreciation is zero in the long run. The exchange rate is static, and is not expected to change because it is at its equilibrium level. Thus:

$$P=m-k\hat{y}+lr^* \quad (\text{A.21})$$

where the capital  $P$  stands for steady state price level. Equation A.21 says the equilibrium price level is the ratio of the money stock to the level of demand when it is at its long run level that is when the domestic and world interest rates are equal.

Using equation A.21 and A.20, it follows that the nominal exchange rate settles at the level:

$$S=(h^{-1}-k) \hat{y}+m+lr^* \quad (\text{A.22})$$

The capital S stands for the steady state nominal exchange rate. A given percentage rise in the money stock pushes up the long run values of the both the nominal exchange rate and the price level in the same proportion, and hence leaves the real exchange rate unchanged.

Let us see how the model behaves out of equilibrium. having said that in the long run the inflation is zero, hence the equation A.19 implies:

$$0=\pi(hs-hp-\hat{y}) \quad (\text{A.23})$$

Subtracting this from equation 19 we get:

$$\Delta p=\pi h(q-Q) \quad (\text{A.24})$$

In other words, the rate of inflation is positive whenever the real exchange rate is above its equilibrium level, and vice versa below. So the combination of  $s$  and  $p$  consistent with zero inflation lie along  $45^\circ$  line in figure A.11.

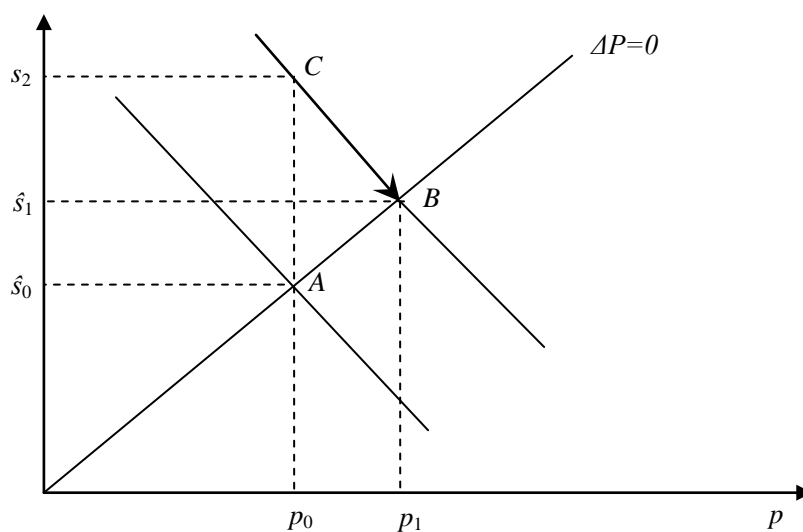


Figure A.11

Applying the same treatment to the money market equation, take equation A.21 from equation A.18 to give:

$$p-P=-l\theta(s-S) \quad (\text{A.25})$$

which shows the conditions necessary for short run equilibrium in the money market. Even in the adjustment phase, the economy lies somewhere along a downward sloping line in figure A.11. The money market lines have a gradient of  $-1/l\theta$ . It follows that they are steeper the less sensitive the demand for money to changes in the exchange rate relative to its equilibrium level. This sensitivity is the product of the interest elasticity and the expectations adjustment parameter.

Return to the initial assumption of monetary expansion. The eventual outcome is to raise both the exchange rate and the price level. However, the sticky price level deters the immediate move from point A to B. Since the good market line is only determined by long run real exchange rate, hence that is going to remain unchanged. On the other hand, the money market clearing conditions are affected. With a larger money stock,

any given exchange rate is consistent with a proportionately higher price level, so that the MM line shifts outward. Again the economy must be on the MM line at all times, but the price level is initially fixed at old level, thus the exchange rate must jump to  $s_2$ , carrying the system to point  $C$  on the downward sloping path. This confirms that the nominal and real exchange rate overshoots in response to a monetary shock. The scale of the overshooting is dependent on the slope of the money market line- the steeper the line, the greater the overshoot.

## A.5 Conclusion

To summarize, in this chapter the researcher intend to overview the exchange rate determination in the literature. It began with the definition of the exchange, then the research deepened in to purchasing power parity, and covered and uncovered interest rate power parity. All these research in fact is to pave the way to understand the three exchange models that could explain the exchange rate determination.

The monetary model combines the theory of the demand for money and purchasing power parity to generate conclusions about the effect of changes in exogenous variables on a floating exchange rate or fixed exchange rate. However, the monetary model can only be regarded as a long run explanation of exchange rate movement, since the purchasing power parity does not hold at any time.

The Mundell-Fleming model is set in the context of a flat aggregate supply curve that is stagnate price level instead of purchasing power parity. Thus this model could explain the exchange rate fluctuation at short term. The Mundell-Fleming model

contrasts with the monetary model in a number of respects: its emphasis on the level of activity and interest rates rather than price level, its concentration on flows of spending and capital movements rather than stocks of assets. With a floating exchange rate, the expansionary monetary policy causes depreciation and a fall in interest rate, while fiscal expansion has the opposite effect. Whereas with a fixed exchange rate, expansionary monetary policy has the long run effect of causing a fall in foreign exchange reserve, while fiscal expansion generate a rise in income and the interest rate in short run. However, the Mundell-Fleming model has the weaknesses of constant price level, which cannot explain the long run exchange rate determination, and static expectations.

As for Dornbusch overshooting model, it appears to explain both long run and short run exchange rate movement. The model's assumption of sticky price is credible and the model demonstrates that a consequence could be over reacted by the exchange rate to a shock. Moreover the model really adopts the idea that the purchasing power parity only holds in long run, thus it generate the same conclusion as the monetary model in the long run but allow for the real effects in the short run.

## Appendix B Derivation of Equation 4.11 in Chapter 4

This Appendix gives a description of how the stationary level of financial exchange rate and foreign reserve adjust with the changes in domestic credit, output, foreign goods price level and foreign interest rate.

By equations (4.7) and (4.10), we know that the  $\dot{s} = 0$  schedule and the  $\dot{f}_t = 0$  schedule respectively have an intercept of  $-G$  and  $H$  in the vertical axis. They can be re-arranged as:

$$\begin{aligned} -G &= -\frac{\beta_1 \cdot \bar{y}}{\beta_2} + \frac{(1-\omega) \cdot \bar{d}}{\beta_2} - \frac{p^*}{\beta_2} - \frac{\bar{e}}{\beta_2} + i^* + \alpha \cdot \bar{e} \\ H &= \frac{1}{\omega \cdot \theta} \{ (\gamma_2 - 1 + \theta) \cdot \left[ \frac{\beta_1 \cdot \bar{y}}{\beta_2} - \frac{(1-\omega) \cdot \bar{d}}{\beta_2} + \frac{p^*}{\beta_2} + \frac{\bar{e}}{\beta_2} - i^* - \alpha \cdot \bar{e} \right] \right. \\ &\quad \left. + \gamma_1 \cdot [\bar{y} + \bar{e} + p^* - (1-\theta) \cdot \bar{k} - \theta(1-\omega) \bar{d}] + \gamma_2 \cdot (i^* + \alpha \bar{e}) \} \end{aligned}$$

In addition, the equilibrium financial exchange rate  $s^e$  and foreign reserve  $f^e$ , which are shown in system (4.12), are as below:

$$\begin{aligned} s^e &= \frac{\omega}{\beta_2} \cdot \chi \cdot \{ \gamma_1 \cdot (1-\theta \cdot \beta_1) \cdot \bar{y} + \gamma_1 \cdot (1-\theta) \cdot p^* - \gamma_1(1-\theta) \cdot \bar{k} + (\gamma_2 + \beta_2) \cdot i^* \\ &\quad + [\gamma_1 \cdot (1-\theta) + \alpha \cdot \gamma_2 + \alpha \cdot \beta_2] \cdot \bar{e} \} \end{aligned}$$

$$\begin{aligned} f^e &= \chi [\sigma \cdot G + \alpha \cdot T] = \chi \cdot \left\{ \sigma \cdot \left[ \frac{\beta_1 \cdot \bar{y}}{\beta_2} - \frac{(1-\omega) \cdot \bar{d}}{\beta_2} + \frac{p^*}{\beta_2} + \frac{\bar{e}}{\beta_2} - i^* - \alpha \cdot \bar{e} \right] \right. \\ &\quad \left. + \alpha \cdot \gamma_1 \cdot [\bar{y} + \bar{e} + p^* - (1-\theta) \cdot \bar{k} - \theta(1-\omega) \bar{d}] + \alpha \cdot \gamma_2 \cdot (i^* + \alpha \bar{e}) \right\} \end{aligned}$$

$$\chi = \frac{1}{\omega} \cdot \frac{\beta_2}{\alpha \cdot \theta \cdot \beta_2 \cdot \gamma_1 + \alpha \cdot \gamma_2 + (1-\theta) \cdot \gamma_1} > 0$$

$$\sigma = \gamma_1 \cdot (1-\theta) + \alpha \cdot \gamma_2 > 0$$

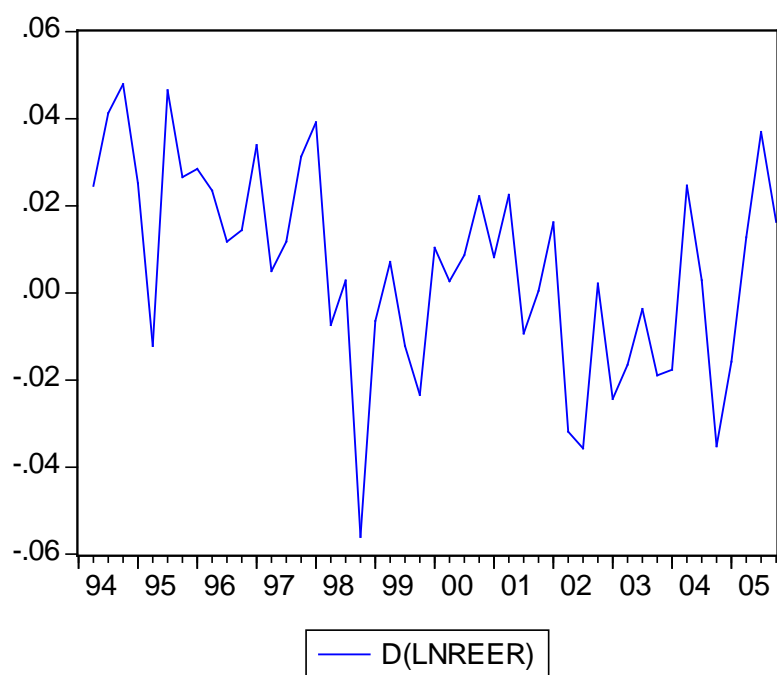
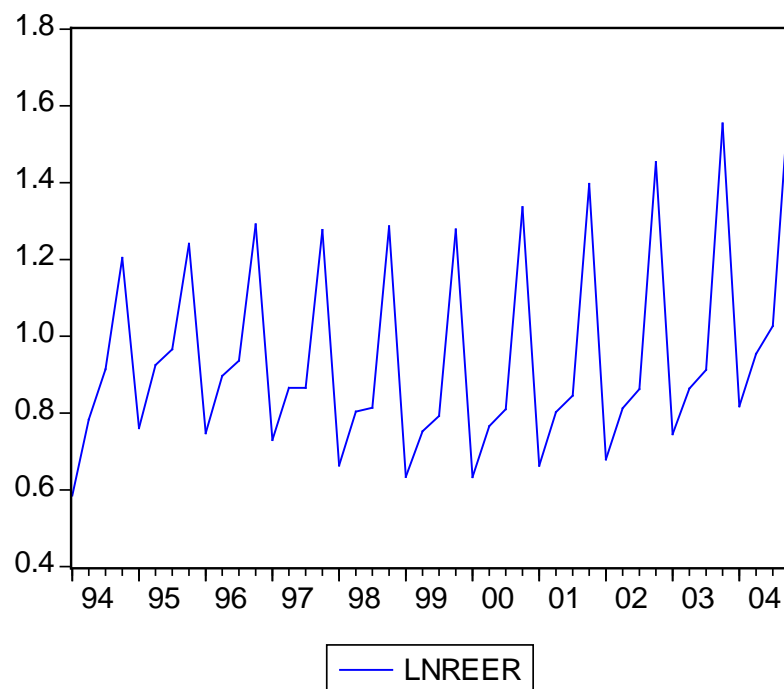
$$s^e = \frac{T - \theta \cdot \beta_2 \cdot \gamma_1 \cdot G}{\alpha \cdot \theta \cdot \beta_2 \cdot \gamma_1 + \alpha \cdot \gamma_2 + (1-\theta) \cdot \gamma_1}$$

$$f^e = \frac{\beta_2}{\omega} \cdot \frac{\gamma_1 \cdot (1-\theta) \cdot G + \alpha \cdot T + \alpha \cdot \gamma_2 \cdot G}{\alpha \cdot \theta \cdot \beta_2 \cdot \gamma_1 + \alpha \cdot \gamma_2 + (1-\theta) \cdot \gamma_1}$$

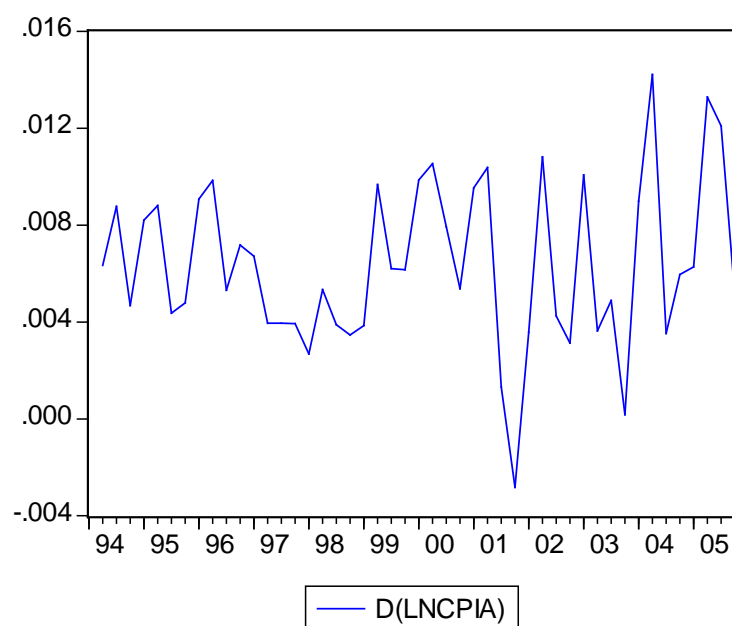
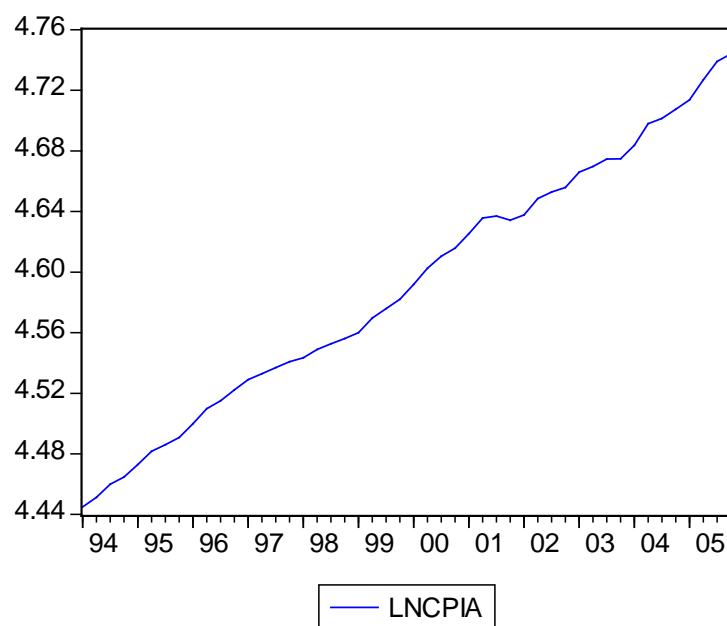


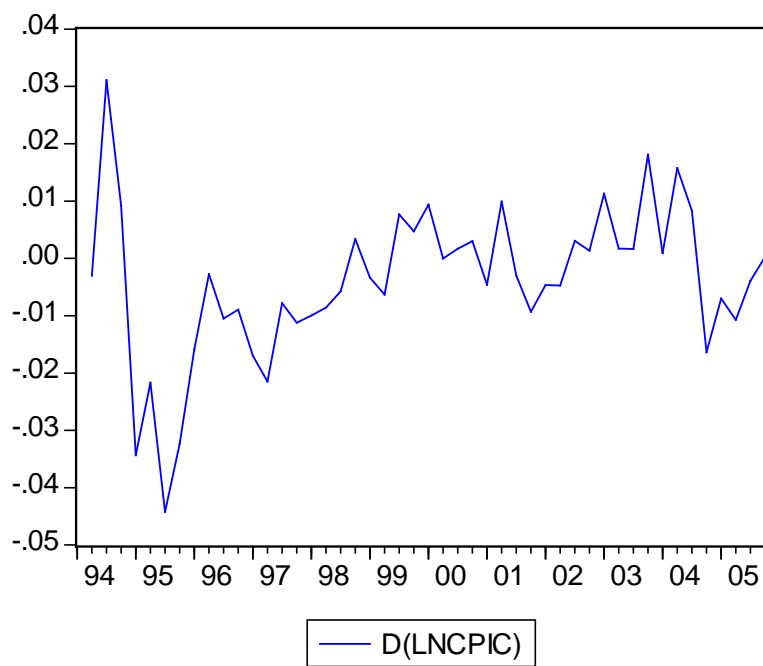
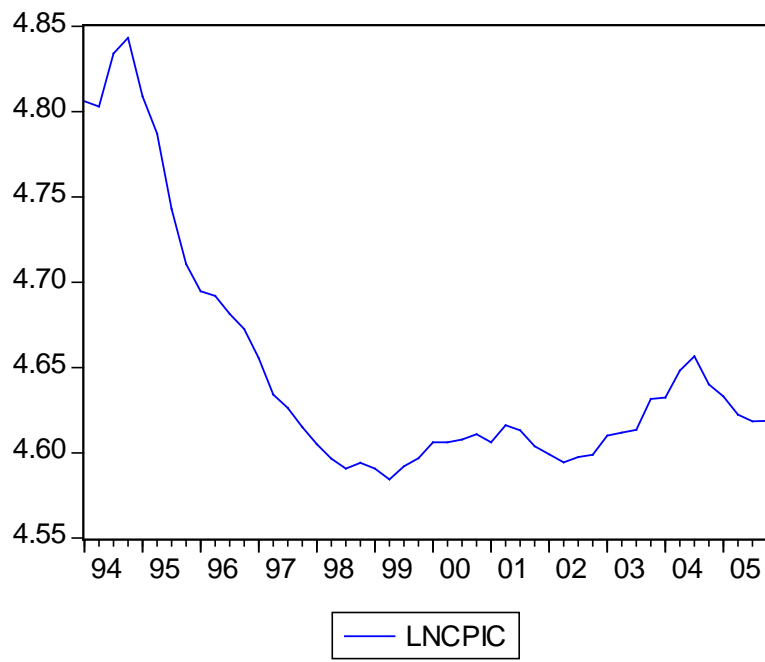
## Appendix C Variables' Graphs

### C.1 Real Exchange Rate

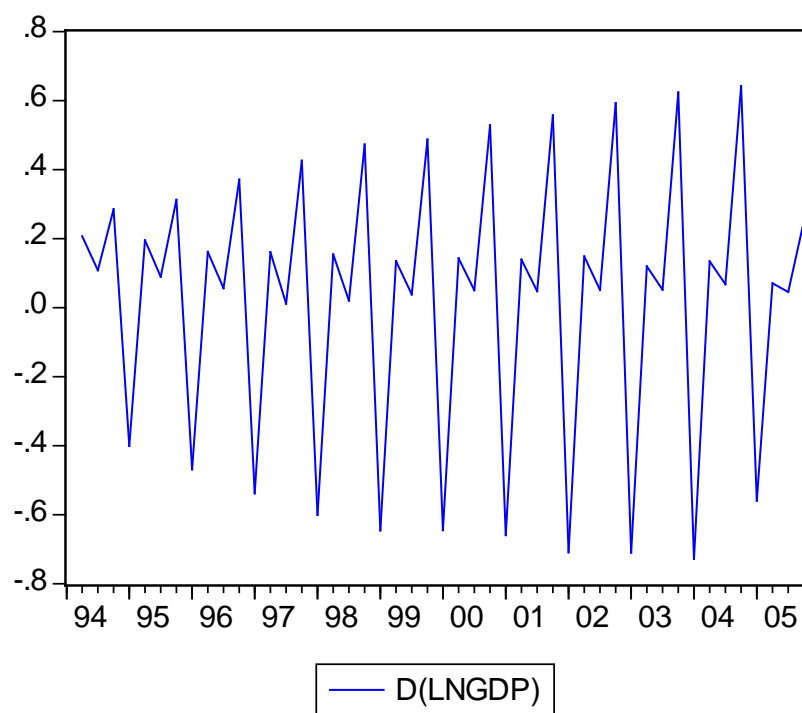
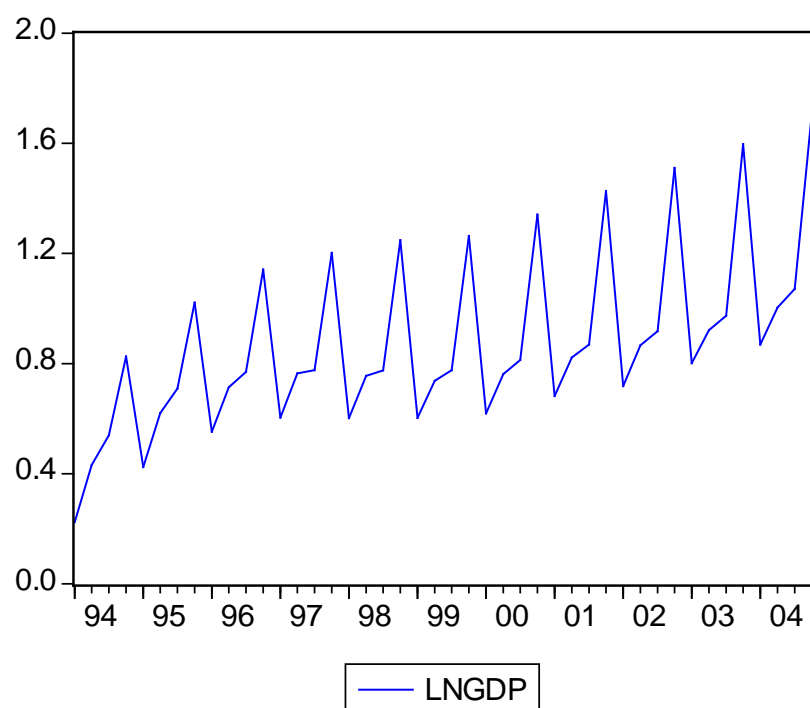


## C.2 Domestic Inflation Rates and Foreign Inflation Rate

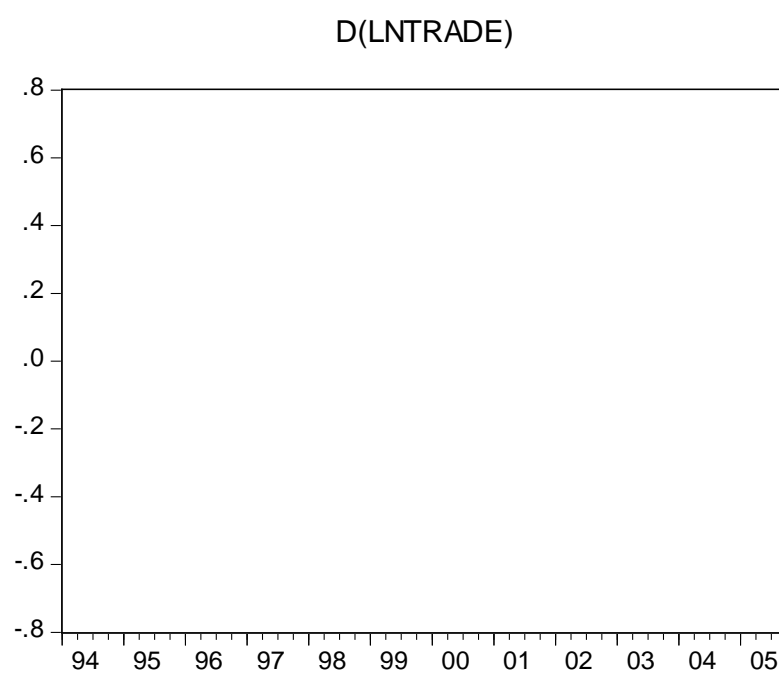
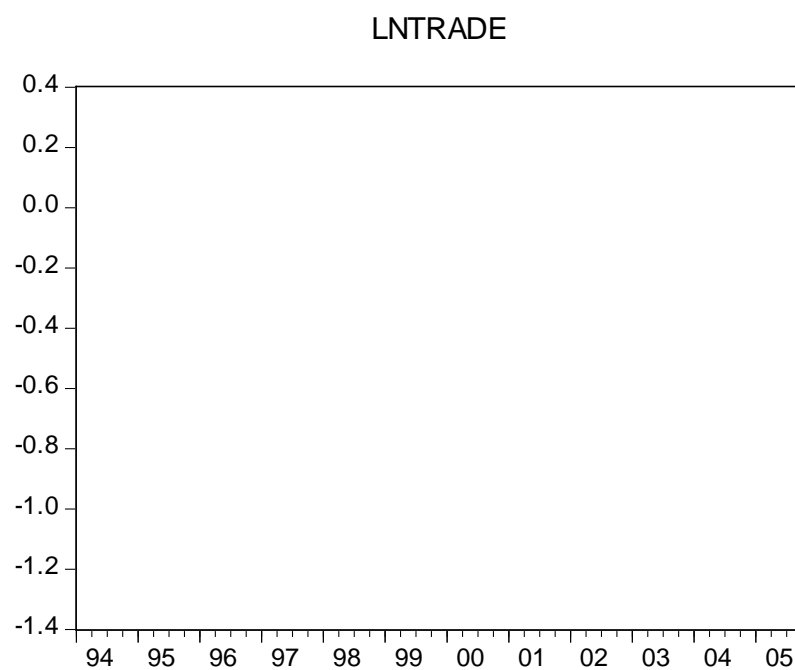




## C.3 Real-GDP



## C.4 Trade-openness



## Appendix D

### Unit Root Test Results for Variables: REER, GDP, CPIa, CPIc, TRADE.

#### D.1 .1 Augmented Dickey-Fuller Unit Root Test on LNREER

Null Hypothesis: LNREER has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.258282	0.0229
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREER)

Method: Least Squares

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNREER(-1)	-0.116256	0.035680	-2.258282	0.0022
D(LNREER(-1))	0.266245	0.130565	2.039175	0.0476
C	0.534326	0.162989	3.278301	0.0021
R-squared	0.319007	Mean dependent var		0.005582
Adjusted R-squared	0.287333	S.D. dependent var		0.023609
S.E. of regression	0.019930	Akaike info criterion		-4.930146
Sum squared resid	0.017081	Schwarz criterion		-4.810887
Log likelihood	116.3934	F-statistic		10.07154
Durbin-Watson stat	1.985769	Prob(F-statistic)		0.000259

### D.1.2 Augmented Dickey-Fuller Unit Root Test on D( LNREER)

Null Hypothesis: D(LNREER) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.437418	0.0009
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNREER,2)

Method: Least Squares

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNREER(-1))	-0.613455	0.138246	-4.437418	0.0001
C	0.003354	0.003340	1.004269	0.3207
R-squared	0.309161	Mean dependent var		-0.000180
Adjusted R-squared	0.293460	S.D. dependent var		0.026174
S.E. of regression	0.022001	Akaike info criterion		-4.752970
Sum squared resid	0.021298	Schwarz criterion		-4.673463
Log likelihood	111.3183	F-statistic		19.69068
Durbin-Watson stat	2.025457	Prob(F-statistic)		0.000060

## D.2.1 Augmented Dickey-Fuller Unit Root Test on LNGDP

Null Hypothesis: LNGDP has a unit root

Exogenous: Constant

Lag Length: 7 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.424405	0.9988
Test critical values: 1% level	-3.605593	
5% level	-2.936942	
10% level	-2.606857	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNGDP)

Method: Least Squares

Sample (adjusted): 1996Q1 2005Q4

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	0.131359	0.092221	1.424405	0.1643
D(LNGDP(-1))	-0.411392	0.322213	-1.276770	0.2112
D(LNGDP(-2))	-0.463819	0.382258	-1.213367	0.2342
D(LNGDP(-3))	-1.846678	0.359254	-5.140312	0.0000
D(LNGDP(-4))	0.495535	0.176696	2.804449	0.0086
D(LNGDP(-5))	-0.208958	0.284742	-0.733850	0.4686
D(LNGDP(-6))	-0.155767	0.346058	-0.450119	0.6558
D(LNGDP(-7))	1.339786	0.345288	3.880195	0.0005
C	-0.094263	0.083848	-1.124216	0.2696
R-squared	0.986764	Mean dependent var		0.012506
Adjusted R-squared	0.983348	S.D. dependent var		0.416776
S.E. of regression	0.053782	Akaike info criterion		-2.812639
Sum squared resid	0.089668	Schwarz criterion		-2.432641
Log likelihood	65.25278	F-statistic		288.8779
Durbin-Watson stat	1.788366	Prob(F-statistic)		0.000000



## D.2.2 Augmented Dickey-Fuller Unit Root Test on D( LNGDP)

Null Hypothesis: D(LNGDP) has a unit root

Exogenous: Constant

Lag Length: 6 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.651279	0.0915
Test critical values: 1% level	-3.605593	
5% level	-2.936942	
10% level	-2.606857	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNGDP,2)

Method: Least Squares

Sample (adjusted): 1996Q1 2005Q4

Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	-1.826498	0.688912	-2.651279	0.0124
D(LNGDP(-1),2)	0.720475	0.681160	1.057719	0.2981
D(LNGDP(-2),2)	0.670439	0.704167	0.952103	0.3482
D(LNGDP(-3),2)	-0.802006	0.722171	-1.110549	0.2750
D(LNGDP(-4),2)	-0.239873	0.609707	-0.393423	0.6966
D(LNGDP(-5),2)	-0.589967	0.469633	-1.256231	0.2181
D(LNGDP(-6),2)	-1.041880	0.279123	-3.732686	0.0007
C	0.023443	0.014433	1.624311	0.1141
R-squared	0.995477	Mean dependent var	-0.001532	
Adjusted R-squared	0.994488	S.D. dependent var	0.735973	
S.E. of regression	0.054640	Akaike info criterion	-2.799242	
Sum squared resid	0.095537	Schwarz criterion	-2.461466	
Log likelihood	63.98485	F-statistic	1006.234	
Durbin-Watson stat	1.726261	Prob(F-statistic)	0.000000	

### D.3.1 Augmented Dickey-Fuller Unit Root Test on LNCPIa

Null Hypothesis: LNCPIa has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	0.389086	0.9804
Test critical values: 1% level	-3.577723	
5% level	-2.925169	
10% level	-2.600658	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNCPIa)

Method: Least Squares

Sample (adjusted): 1994Q2 2005Q4

Included observations: 47 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCPIA(-1)	0.002399	0.006166	0.389086	0.6990
C	-0.004640	0.028292	-0.164012	0.8705
R-squared	0.003353	Mean dependent var		0.006366
Adjusted R-squared	-0.018795	S.D. dependent var		0.003432
S.E. of regression	0.003464	Akaike info criterion		-8.450936
Sum squared resid	0.000540	Schwarz criterion		-8.372207
Log likelihood	200.5970	F-statistic		0.151388
Durbin-Watson stat	1.639500	Prob(F-statistic)		0.699048

### D.3.2 Augmented Dickey-Fuller Unit Root Test on D( LNCPIa)

Null Hypothesis: D(LNCPIa) has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.827729	0.0000
Test critical values: 1% level	-3.584743	
5% level	-2.928142	
10% level	-2.602225	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNCPIa,2)

Method: Least Squares

Sample (adjusted): 1994Q4 2005Q4

Included observations: 45 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCPIA(-1))	-1.088494	0.186778	-5.827729	0.0000
D(LNCPIA(-1),2)	0.340107	0.150386	2.261567	0.0290
C	0.006836	0.001281	5.334882	0.0000
R-squared	0.473878	Mean dependent var		-8.22E-05
Adjusted R-squared	0.448824	S.D. dependent var		0.004465
S.E. of regression	0.003315	Akaike info criterion		-8.516537
Sum squared resid	0.000461	Schwarz criterion		-8.396093
Log likelihood	194.6221	F-statistic		18.91468
Durbin-Watson stat	1.866813	Prob(F-statistic)		0.000001

#### D.4.1 Augmented Dickey-Fuller Unit Root Test on LNCPIC

Null Hypothesis: LNCPIC has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.431094	0.1391
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNCPIC)

Method: Least Squares

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCPIC(-1)	-0.059382	0.024426	-2.431094	0.0193
D(LNCPIC(-1))	0.463479	0.124511	3.722406	0.0006
C	0.273794	0.113410	2.414190	0.0201
R-squared	0.357759	Mean dependent var	-0.004004	
Adjusted R-squared	0.327888	S.D. dependent var	0.013579	
S.E. of regression	0.011132	Akaike info criterion	-6.094956	
Sum squared resid	0.005329	Schwarz criterion	-5.975697	
Log likelihood	143.1840	F-statistic	11.97654	
Durbin-Watson stat	1.817852	Prob(F-statistic)	0.000073	

#### D.4.2 Augmented Dickey-Fuller Unit Root Test on D( LNCPIC)

Null Hypothesis: D(LNCPIC) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.723626	0.0068
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNCPIC,2)

Method: Least Squares

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCPIC(-1))	-0.480315	0.128991	-3.723626	0.0006
C	-0.001886	0.001809	-1.042485	0.3029
R-squared	0.239615	Mean dependent var		7.28E-05
Adjusted R-squared	0.222333	S.D. dependent var		0.013309
S.E. of regression	0.011737	Akaike info criterion		-6.009648
Sum squared resid	0.006061	Schwarz criterion		-5.930142
Log likelihood	140.2219	F-statistic		13.86539
Durbin-Watson stat	1.814127	Prob(F-statistic)		0.000555

### D.5.1 Augmented Dickey-Fuller Unit Root Test on LNTRADE

Null Hypothesis: LNTRADE has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.320341	0.0195
Test critical values: 1% level	-3.577723	
5% level	-2.925169	
10% level	-2.600658	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNTRADE)

Method: Least Squares

Date: 04/29/09 Time: 19:28

Sample (adjusted): 1994Q2 2005Q4

Included observations: 47 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LNTRADE(-1)	-0.356878	0.107482	-3.320341	0.0018
C	-0.134818	0.052697	-2.558357	0.0140
R-squared	0.196782	Mean dependent var		-0.011077
Adjusted R-squared	0.178933	S.D. dependent var		0.281885
S.E. of regression	0.255424	Akaike info criterion		0.149838
Sum squared resid	2.935865	Schwarz criterion		0.228568
Log likelihood	-1.521193	Hannan-Quinn criter.		0.179465
F-statistic	11.02466	Durbin-Watson stat		1.997366
Prob(F-statistic)	0.001789			

## D.5.2 Augmented Dickey-Fuller Unit Root Test on D(LNTRADE)

Null Hypothesis: D(LNTRADE) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.996494	0.0000
Test critical values: 1% level	-3.581152	
5% level	-2.926622	
10% level	-2.601424	

\*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LNTRADE,2)

Method: Least Squares

Date: 04/29/09 Time: 19:29

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
D(LNTRADE(-1))	-1.170384	0.146362	-7.996494	0.0000
C	-0.005962	0.041285	-0.144406	0.8858
R-squared	0.592381	Mean dependent var		0.006571
Adjusted R-squared	0.583117	S.D. dependent var		0.433367
S.E. of regression	0.279810	Akaike info criterion		0.333090
Sum squared resid	3.444911	Schwarz criterion		0.412596
Log likelihood	-5.661073	Hannan-Quinn criter.		0.362874
F-statistic	63.94391	Durbin-Watson stat		2.072691
Prob(F-statistic)	0.000000			

## Appendix E Johansen Cointegration Test

Date: 05/06/09 Time: 17:01

Sample (adjusted): 1994Q3 2005Q4

Included observations: 46 after adjustments

Trend assumption: No deterministic trend (restricted constant)

Series: LNGDP LNCPIA LNCPIA LNTRADE LNREER

Lags interval (in first differences): 1 to 1

### Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.692293	149.9597	76.97277	0.0000
At most 1 *	0.621383	95.74384	54.07904	0.0000
At most 2 *	0.436209	51.06722	35.19275	0.0005
At most 3 *	0.321225	24.70595	20.26184	0.0114
At most 4	0.138965	6.882545	9.164546	0.1327

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.692293	54.21588	34.80587	0.0001
At most 1 *	0.621383	44.67662	28.58808	0.0002
At most 2 *	0.436209	26.36126	22.29962	0.0128
At most 3 *	0.321225	17.82341	15.89210	0.0246
At most 4	0.138965	6.882545	9.164546	0.1327

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values

### Unrestricted Cointegrating Coefficients (normalized by b\*S11\*b=I):

LNGDP	LNCPIA	LNCPIA	LNTRADE	LNREER	C
6.679126	7.467374	-16.12334	0.504145	4.392003	13.88141
2.904502	32.01611	-2.654956	0.112225	26.10810	-260.2940
-2.058078	29.89589	15.86384	-2.528068	9.901277	-254.8916
-1.133268	18.08308	7.703045	2.117935	20.21419	-208.8648



0.037654	-21.41325	4.180407	-3.059097	-12.01214	134.0662
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Unrestricted Adjustment Coefficients (alpha):

D(LNGDP)	-0.228416	-0.084803	0.073411	0.036555	-0.023945
D(LNCPIC)	-0.003209	-0.003077	-0.006145	-0.000484	0.001239
D(LNCPIA)	0.002601	-0.001926	-1.50E-06	0.000217	0.000307
D(LNTRADE)	0.005067	-0.008314	0.052021	-0.024563	0.086953
D(LNREER)	0.002598	-0.003614	0.000849	-0.009925	-0.002586

1 Cointegrating Equation(s):      Log likelihood      463.8484

Normalized cointegrating coefficients (standard error in parentheses)

LNGDP	LNCPIC	LNCPIA	LNTRADE	LNREER	C
1.000000	1.118017	-2.413989	0.075481	0.657572	2.078327
	(0.82894)	(0.34022)	(0.07050)	(0.56879)	(7.13015)

Adjustment coefficients (standard error in parentheses)

D(LNGDP)	-1.525616
	(0.24858)
D(LNCPIC)	-0.021432
	(0.01148)
D(LNCPIA)	0.017369
	(0.00331)
D(LNTRADE)	0.033842
	(0.26425)
D(LNREER)	0.017352
	(0.02060)

2 Cointegrating Equation(s):      Log likelihood      486.1867

Normalized cointegrating coefficients (standard error in parentheses)

LNGDP	LNCPIC	LNCPIA	LNTRADE	LNREER	C
1.000000	0.000000	-2.583291	0.079639	-0.282820	12.42848
		(0.33048)	(0.08083)	(0.28978)	(1.42502)
0.000000	1.000000	0.151431	-0.003720	0.841125	-9.257605
		(0.08307)	(0.02032)	(0.07284)	(0.35819)

Adjustment coefficients (standard error in parentheses)

D(LNGDP)	-1.771926	-4.420711
	(0.25286)	(1.14135)
D(LNCPIC)	-0.030369	-0.122477

	(0.01201)	(0.05419)
D(LNCPIA)	0.011776	-0.042235
	(0.00284)	(0.01283)
D(LNTRADE)	0.009693	-0.228360
	(0.28800)	(1.29997)
D(LNREER)	0.006856	-0.096294
	(0.02207)	(0.09963)

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3 Cointegrating Equation(s):                      Log likelihood                      499.3674

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Normalized cointegrating coefficients (standard error in parentheses)

LNGDP	LNCPIA	LNCPIA	LNTRADE	LNREER	C
1.000000	0.000000	0.000000	-0.887136	-7.074378	32.79058
			(0.43711)	(1.55879)	(7.11542)
0.000000	1.000000	0.000000	0.052952	1.239241	-10.45122
			(0.03737)	(0.13327)	(0.60834)
0.000000	0.000000	1.000000	-0.374242	-2.629033	7.882232
			(0.15439)	(0.55058)	(2.51326)

Adjustment coefficients (standard error in parentheses)

D(LNGDP)	-1.923012	-2.226013	5.072554
	(0.24764)	(1.45393)	(0.74517)
D(LNCPIA)	-0.017722	-0.306185	-0.037577
	(0.01008)	(0.05917)	(0.03033)
D(LNTRADE)	0.011779	-0.042280	-0.036840
	(0.00295)	(0.01734)	(0.00889)
D(LNREER)	-0.097370	1.326856	0.765633
	(0.29273)	(1.71866)	(0.88085)
D(LNREER)	0.005109	-0.070909	-0.018824
	(0.02291)	(0.13453)	(0.06895)

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4 Cointegrating Equation(s):                      Log likelihood                      508.2791

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Normalized cointegrating coefficients (standard error in parentheses)

LNGDP	LNCPIA	LNCPIA	LNTRADE	LNREER	C
1.000000	0.000000	0.000000	0.000000	-4.142616	20.10739
				(1.65675)	(7.64343)
0.000000	1.000000	0.000000	0.000000	1.064248	-9.694173
				(0.13570)	(0.62605)
0.000000	0.000000	1.000000	0.000000	-1.392258	2.531780
				(0.60995)	(2.81402)
0.000000	0.000000	0.000000	1.000000	3.304750	-14.29678
				(1.00544)	(4.63862)

---

Adjustment coefficients (standard error in parentheses)

D(LNGDP)	-1.964438 (0.24646)	-1.564990 (1.54502)	5.354138 (0.77427)	-0.232840 (0.10751)
D(LNCPIC)	-0.017174 (0.01017)	-0.314937 (0.06378)	-0.041305 (0.03196)	0.012547 (0.00444)
D(LNCPIA)	0.011533 (0.00297)	-0.038359 (0.01865)	-0.035170 (0.00934)	0.001558 (0.00130)
D(LNTRADE)	-0.069533 (0.29450)	0.882673 (1.84614)	0.576420 (0.92517)	-0.181915 (0.12846)
D(LNREER)	0.016356 (0.01981)	-0.250381 (0.12421)	-0.095276 (0.06225)	-0.022263 (0.00864)

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## Appendix F Vector Auto-regression Estimates Result

Vector Autoregression Estimates

Date: 05/05/09 Time: 17:22

Sample (adjusted): 1995Q4 2005Q4

Included observations: 41 after adjustments

Standard errors in ( ) & t-statistics in [ ]

	LNGDP	LNCPIC	LNCPIA	LNTRADE	LNREER
LNGDP(-1)	-0.308128 (1.01774) [-0.30276]	-0.167447 (0.12598) [-1.32920]	-0.068880 (0.06528) [-1.05509]	-0.589893 (3.49909) [-0.16858]	0.657900 (0.15546) [ 4.23190]
LNGDP(-2)	-1.006483 (0.88349) [-1.13921]	0.073878 (0.10936) [ 0.67556]	-0.078202 (0.05667) [-1.37991]	0.803713 (3.03754) [ 0.26459]	0.189148 (0.13496) [ 1.40156]
LNGDP(-3)	-1.902518 (0.56345) [-3.37657]	0.093415 (0.06974) [ 1.33941]	-0.036156 (0.03614) [-1.00037]	0.224514 (1.93718) [ 0.11590]	-0.144641 (0.08607) [-1.68055]
LNGDP(-4)	0.836607 (0.22677) [ 3.68915]	-0.015365 (0.02807) [-0.54737]	-0.020227 (0.01455) [-1.39049]	-1.298343 (0.77967) [-1.66524]	0.026704 (0.03464) [ 0.77089]
LNGDP(-5)	-0.034163 (0.99261) [-0.03442]	0.171261 (0.12286) [ 1.39390]	0.059008 (0.06367) [ 0.92676]	-1.770757 (3.41268) [-0.51888]	-0.558601 (0.15162) [-3.68416]
LNGDP(-6)	0.795156 (0.87781) [ 0.90584]	-0.123457 (0.10866) [-1.13623]	0.079131 (0.05631) [ 1.40533]	-3.295990 (3.01800) [-1.09211]	-0.107856 (0.13409) [-0.80437]
LNGDP(-7)	1.870196 (0.54411) [ 3.43714]	-0.136249 (0.06735) [-2.02301]	0.030293 (0.03490) [ 0.86794]	-1.543696 (1.87072) [-0.82519]	0.177737 (0.08311) [ 2.13846]
LNCPIC(-1)	-4.651812 (2.70715) [-1.71835]	1.289338 (0.33509) [ 3.84776]	-0.058987 (0.17365) [-0.33968]	17.22523 (9.30742) [ 1.85070]	-0.368395 (0.41352) [-0.89087]
LNCPIC(-2)	1.070982 (4.40818)	-1.013900 (0.54564)	-0.361076 (0.28277)	-9.717693 (15.1557)	3.085581 (0.67336)

	[ 0.24295]	[-1.85818]	[-1.27695]	[-0.64119]	[ 4.58238]
LNCPIC(-3)	-1.660447 (4.68677) [-0.35428]	1.151849 (0.58013) [ 1.98552]	0.069933 (0.30064) [ 0.23262]	-22.63979 (16.1136) [-1.40501]	-1.124043 (0.71591) [-1.57008]
LNCPIC(-4)	3.745507 (3.30072) [ 1.13475]	-0.820834 (0.40856) [-2.00909]	0.269711 (0.21173) [ 1.27386]	2.191470 (11.3482) [ 0.19311]	-1.113541 (0.50419) [-2.20857]
LNCPIC(-5)	0.454447 (2.56718) [ 0.17702]	0.138173 (0.31776) [ 0.43483]	0.016768 (0.16467) [ 0.10183]	12.86402 (8.82621) [ 1.45748]	-0.849538 (0.39214) [-2.16641]
LNCPIC(-6)	-1.103995 (2.01718) [-0.54730]	0.134174 (0.24969) [ 0.53737]	-0.012194 (0.12939) [-0.09424]	9.203778 (6.93526) [ 1.32710]	1.270916 (0.30813) [ 4.12463]
LNCPIC(-7)	1.210142 (1.75289) [ 0.69037]	-0.061718 (0.21697) [-0.28445]	0.006083 (0.11244) [ 0.05410]	-16.61041 (6.02661) [-2.75618]	-0.256723 (0.26776) [-0.95879]
LNCPIA(-1)	-2.505454 (5.85274) [-0.42808]	2.049990 (0.72445) [ 2.82973]	1.046932 (0.37543) [ 2.78864]	-31.06039 (20.1223) [-1.54358]	2.582792 (0.89402) [ 2.88897]
LNCPIA(-2)	4.748401 (12.7527) [ 0.37234]	-3.642772 (1.57853) [-2.30771]	0.630903 (0.81803) [ 0.77124]	-17.96111 (43.8452) [-0.40965]	-2.499035 (1.94801) [-1.28287]
LNCPIA(-3)	9.673716 (10.4084) [ 0.92942]	1.380254 (1.28834) [ 1.07134]	0.249472 (0.66765) [ 0.37366]	63.74422 (35.7849) [ 1.78131]	-2.880430 (1.58990) [-1.81171]
LNCPIA(-4)	-1.967065 (11.2876) [-0.17427]	-0.542249 (1.39717) [-0.38811]	-0.864850 (0.72405) [-1.19447]	21.45549 (38.8077) [ 0.55287]	0.290836 (1.72420) [ 0.16868]
LNCPIA(-5)	-12.88522 (12.5219) [-1.02902]	2.589744 (1.54995) [ 1.67086]	0.502120 (0.80322) [ 0.62513]	-68.25345 (43.0514) [-1.58539]	4.763866 (1.91274) [ 2.49060]
LNCPIA(-6)	10.92661 (13.3458)	-4.472078 (1.65194)	-0.272390 (0.85608)	-0.430001 (45.8842)	4.443083 (2.03860)

	[ 0.81873]	[-2.70717]	[-0.31818]	[-0.00937]	[ 2.17948]
LNCPIA(-7)	-4.109025 (9.36283) [-0.43887]	2.898396 (1.15892) [ 2.50094]	-0.052993 (0.60058) [-0.08824]	50.60869 (32.1903) [ 1.57217]	-8.133646 (1.43019) [-5.68711]
LNTRADE(-1)	-0.013824 (0.06998) [-0.19754]	-0.000469 (0.00866) [-0.05417]	-0.002824 (0.00449) [-0.62920]	-0.516383 (0.24060) [-2.14623]	0.026577 (0.01069) [ 2.48625]
LNTRADE(-2)	0.077531 (0.05929) [ 1.30762]	-0.015836 (0.00734) [-2.15773]	-0.005211 (0.00380) [-1.37023]	-0.271866 (0.20385) [-1.33365]	-0.023578 (0.00906) [-2.60328]
LNTRADE(-3)	-0.046127 (0.08777) [-0.52556]	0.027506 (0.01086) [ 2.53189]	0.007140 (0.00563) [ 1.26823]	0.149919 (0.30175) [ 0.49683]	-0.002818 (0.01341) [-0.21019]
LNTRADE(-4)	0.058219 (0.09881) [ 0.58922]	-0.036318 (0.01223) [-2.96953]	-0.000126 (0.00634) [-0.01994]	-0.004857 (0.33971) [-0.01430]	0.013635 (0.01509) [ 0.90344]
LNTRADE(-5)	-0.003533 (0.09223) [-0.03830]	0.015732 (0.01142) [ 1.37804]	0.000698 (0.00592) [ 0.11794]	0.227886 (0.31709) [ 0.71868]	-0.020199 (0.01409) [-1.43379]
LNTRADE(-6)	-0.057064 (0.08207) [-0.69533]	0.004757 (0.01016) [ 0.46832]	-0.007099 (0.00526) [-1.34856]	-0.024860 (0.28215) [-0.08811]	-0.019114 (0.01254) [-1.52474]
LNTRADE(-7)	-0.008677 (0.09876) [-0.08786]	-0.006802 (0.01222) [-0.55641]	-0.004381 (0.00634) [-0.69150]	-0.789433 (0.33955) [-2.32497]	0.084970 (0.01509) [ 5.63247]
LNREER(-1)	-1.530619 (0.95659) [-1.60008]	0.201024 (0.11841) [ 1.69774]	0.034871 (0.06136) [ 0.56829]	-1.167499 (3.28885) [-0.35499]	0.747533 (0.14612) [ 5.11584]
LNREER(-2)	0.737987 (1.57077) [ 0.46982]	-0.552703 (0.19443) [-2.84269]	-0.201087 (0.10076) [-1.99573]	-4.662835 (5.40047) [-0.86341]	0.205798 (0.23994) [ 0.85771]
LNREER(-3)	-0.587804 (2.19640)	0.641586 (0.27187)	0.060629 (0.14089)	2.080018 (7.55142)	0.062026 (0.33550)

	[-0.26762]	[ 2.35992]	[ 0.43033]	[ 0.27545]	[ 0.18487]
LNREER(-4)	0.454511 (2.02675) [ 0.22426]	-0.413745 (0.25087) [-1.64924]	-0.020785 (0.13001) [-0.15988]	0.071479 (6.96817) [ 0.01026]	-0.247402 (0.30959) [-0.79913]
LNREER(-5)	-0.503725 (1.66204) [-0.30308]	0.059537 (0.20573) [ 0.28940]	0.088829 (0.10661) [ 0.83319]	-1.158932 (5.71425) [-0.20281]	0.641245 (0.25388) [ 2.52578]
LNREER(-6)	-0.888229 (1.53765) [-0.57765]	-0.136789 (0.19033) [-0.71870]	-0.046290 (0.09863) [-0.46932]	2.721394 (5.28660) [ 0.51477]	-0.151944 (0.23488) [-0.64690]
LNREER(-7)	-0.454292 (1.36036) [-0.33395]	0.145339 (0.16838) [ 0.86314]	-0.078659 (0.08726) [-0.90142]	-6.994929 (4.67705) [-1.49559]	0.465248 (0.20780) [ 2.23895]
R-squared	0.996837	0.995385	0.999770	0.970475	0.997615
Adj. R-squared	0.978911	0.969232	0.998469	0.803164	0.984098
Sum sq. resids	0.011705	0.000179	4.82E-05	0.138356	0.000273
S.E. equation	0.044168	0.005467	0.002833	0.151853	0.006747
F-statistic	55.61066	38.06096	768.4160	5.800448	73.80503
Log likelihood	109.1308	194.7903	221.7414	58.49922	186.1674
Akaike AIC	-3.616138	-7.794650	-9.109337	-1.146304	-7.374019
Schwarz SC	-2.153333	-6.331845	-7.646532	0.316502	-5.911213
Mean dependent	0.970259	4.622673	4.612517	-0.349481	4.586891
S.D. dependent	0.304146	0.031168	0.072415	0.342272	0.053501
Determinant resid covariance (dof adj.)	1.82E-19				
Determinant resid covariance	1.22E-23				
Log likelihood	790.7028				
Akaike information criterion	-30.03428				
Schwarz criterion	-22.72026				

## Appendix G Structural VAR Estimates Result

### Structural VAR Estimates

Date: 05/06/09 Time: 17:22

Sample (adjusted): 1995Q4 2005Q4

Included observations: 41 after adjustments

Estimation method: method of scoring (analytic derivatives)

Convergence achieved after 13 iterations

Structural VAR is just-identified

Model:  $Ae = Bu$  where  $E[uu'] = I$

Restriction Type: long-run pattern matrix

Long-run response pattern:

C(1)	0	0	0	0
C(2)	C(6)	0	0	0
C(3)	C(7)	C(10)	0	0
C(4)	C(8)	C(11)	C(13)	0
C(5)	C(9)	C(12)	C(14)	C(15)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.277478	0.030642	9.055385	0.0000
C(2)	1.639992	0.192788	8.506711	0.0000
C(3)	1.579442	0.185196	8.528467	0.0000
C(4)	-0.044140	0.028757	-1.534930	0.1248
C(5)	1.577929	0.185326	8.514347	0.0000
C(6)	0.423166	0.046731	9.055385	0.0000
C(7)	0.398086	0.044077	9.031699	0.0000
C(8)	0.153226	0.022735	6.739583	0.0000
C(9)	0.402792	0.044755	8.999972	0.0000
C(10)	0.020400	0.002253	9.055385	0.0000
C(11)	0.032494	0.014755	2.202294	0.0276
C(12)	0.030586	0.003610	8.472961	0.0000
C(13)	0.091638	0.010120	9.055385	0.0000
C(14)	-0.007063	0.001007	-7.013939	0.0000
C(15)	0.004078	0.000450	9.055385	0.0000

Log likelihood 593.7170

Estimated A matrix:

1.000000	0.000000	0.000000	0.000000	0.000000
0.000000	1.000000	0.000000	0.000000	0.000000
0.000000	0.000000	1.000000	0.000000	0.000000
0.000000	0.000000	0.000000	1.000000	0.000000
0.000000	0.000000	0.000000	0.000000	1.000000



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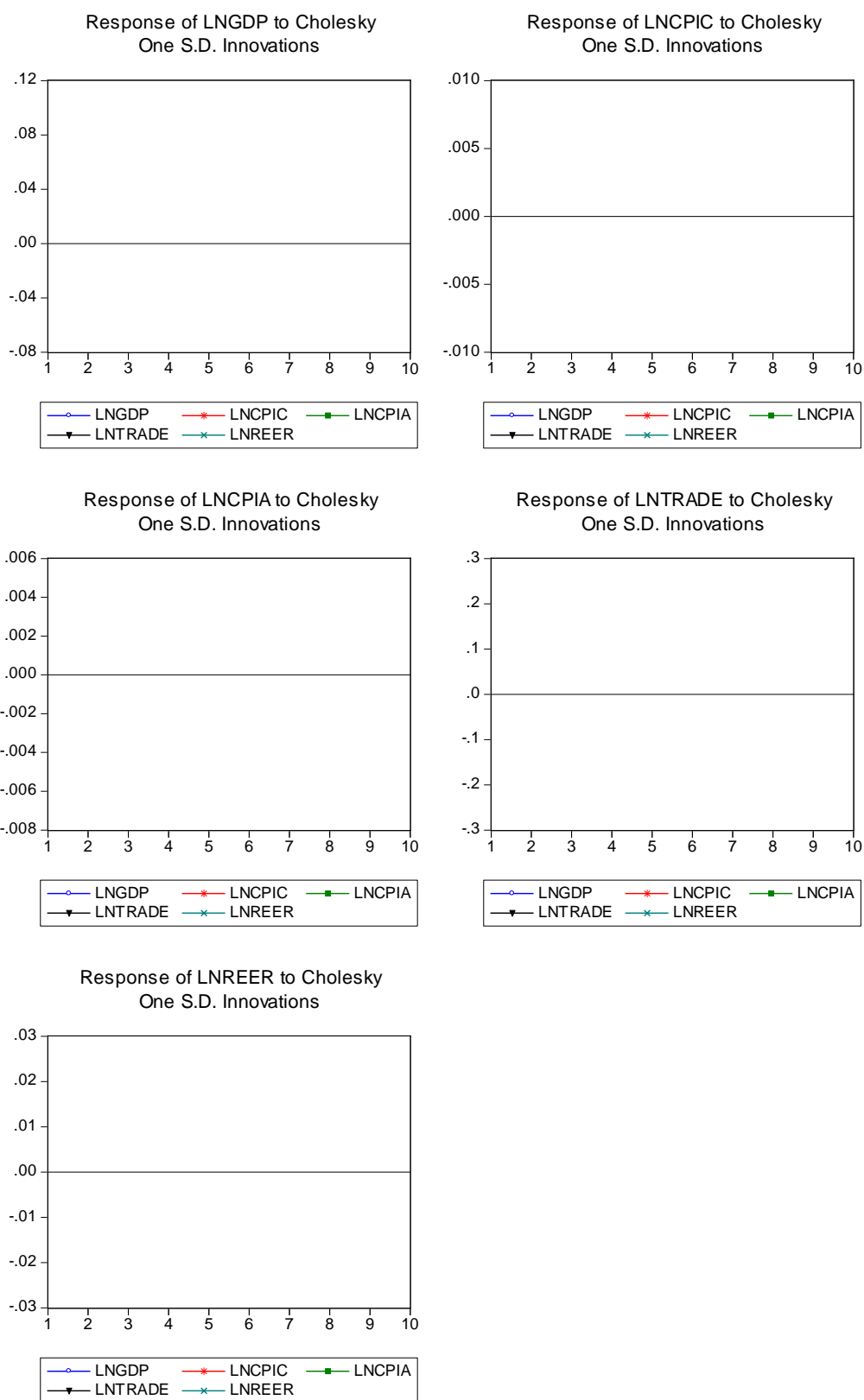
Estimated B matrix:

0.015163	0.034014	0.005386	-0.020177	-0.011305
-0.003613	0.002402	-0.003254	0.000654	-0.000227
-0.002219	-0.001561	0.000474	-6.59E-05	-0.000663
-0.030833	0.028413	-0.018178	0.139965	-0.037158
-0.001888	0.002489	0.005192	-0.000347	0.002947

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## Appendix H Impulse Response Function



## Appendix I Variance Decomposition

